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# Philips C3 Patient Monitor

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## C3 Service Guide Models: 862474, 862478

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Part Number 989803129451  
Printed in the U.S.A. March 2003  
Edition 1



**PHILIPS**

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<b>Additional Documents</b>	<p>Use this document in conjunction with the <b>C3 Instructions for Use</b> guide (pn 989803228691).</p>

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## Safety

All warnings, precautions and notes are located in the chapters that follow. You must read all of this safety information before you begin monitoring with your C3 patient monitor.

### Safety Standards

The C3 Patient Monitor is compliant with the following safety standards:

- UL 2601-1
- CAN/CSA C22.2 No. 601.1-M90
- EN60601-1
- EN60601-2-27
- EN60601-2-30
- EN60601-2-49
- EN865

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The following products and accessories from Philips Medical Systems carry the CE mark to Council Directive 93/42/EEC.



C3 Products: - 862474 - 862478

Accessories: - 21075A - 21076A - 21078A - 21090A  
- M1837A - M4820A - M4818A

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Accessories: - M1191A - M1192A - M1194A - M1941A  
- 40493D - 40493E - M1980A - M1981A  
- M1510A - M1550C - M1611A - M1613A  
- M1615A - M1879A - M1878A - M1877A  
- M1876A - M1875A - M1874A - M1576A  
- M1575A - M1574A - M1573A - M1572A  
- M1571A - M1577A - M1578A - M1579A  
- 40401E - 40401D - 40401C - 40401B  
- 40401A - M1598B - M1599B - M2526A  
- M2525A - M2524A - M2528A - M2522A  
- M2521A - M2520A - M1920A - M1922A  
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**Note**

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**United States** United States Federal Law restricts this device to sale by or on the order of a physician.

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Text Conventions

The following conventions for Notes, Cautions, and Warnings are used in this manual.

**Warning**

A **Warning** calls attention to a condition or possible situation that could cause injury to the user and/or patient.

**Caution**

A **Caution** calls attention to a condition or possible situation that could damage or destroy the product or the user’s work.

**Note**

A **Note** calls attention to an important point in the text.

Explanation of Symbols

Symbols on products and packaging mean the following. All symbols found in this section are used this Instructions For Use guide.

**REF**

Reference Number

**SN**


Serial Number

**CE**  
0123

CE Marking

%  
5% to 95% RH

Humidity

 **+80°C**  
**-20°C**

Temperature Limits



Keep out of Sun



Keep Dry



Fragile



Keep Upright



AC LED



Battery LED



NBP



Volume



Contrast



On/Standby



Snapshot



Continuous



Defibrillator-proof type CF equipment



ECG

***T***

Temperature

***SpO<sub>2</sub>***

SpO<sub>2</sub>



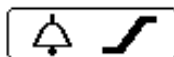
NBP

***CO<sub>2</sub>***

Carbon Dioxide



Alarm



Alarm Limits Menu



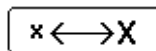
Audio Off



Silence/Reset



NBP Automatic Interval Mode



Big Numbers



Clock



Up Alarm Arrow Limit



Down Alarm Arrow Limit





Empty Battery



Perfusion Indicator Bar



Heart Rate



Powering Down



Heart Rate taken from ECG



Heart Rate taken from NBP



Heart Rate taken from SpO<sub>2</sub>



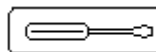
Respiration



Stat Mode



Audio Pause



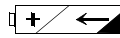
Setup Menu



ECG Size Bar



RF Interference



Battery Compartment

5448



RS-232 I/O



Equipotential Grounding Post



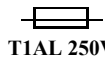
Defib Sync



Attention, consult accompanying documents



Alternating Current



Fuse Type

T1AL 250V



Date of Manufacture (Y= year; X = Month)

YYYY-XX

**IPX1**

Drip-proof



ETL Mark

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# Overview

This chapter provides a brief overview of the C3 patient monitor. It also provides a list of the monitor's features and parameters.

---

## General Safety Information

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### **Warning**

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**This monitor is not intended for neonates.**

**If you connect the monitor to any instrument, verify proper operation before clinical use. Refer to that instrument's Instructions for Use guide for full instructions.**

**Accessory equipment connected to the monitor's data interface must be certified according to IEC Standard 60950 for data-processing equipment or IEC Standard 60601-1 for electromedical equipment. All combinations of equipment must be in compliance with IEC Standard 60601-1-1 systems requirements.**

**Anyone who connects additional equipment to the signal input port or signal output port configures a medical system and is therefore responsible to ensure that the system complies with the requirements of system standard IEC Standard 60601-1-1. If in doubt, contact the Philips' Response Center or your local Philips representative.**

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### **Note**

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The monitor and its accessories must be tested by qualified service personnel at regular intervals to verify proper operation, according to the procedures of the user's institution.

Other important safety information is located in this **Service Guide** where appropriate.

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## Introduction

This manual contains information for servicing the C3 patient monitor, subsequently referred to as "the monitor" throughout this manual. Only qualified service personnel should service this product. Before servicing the monitor, carefully read the **C3 Instructions for Use** guide for a thorough understanding of operation.

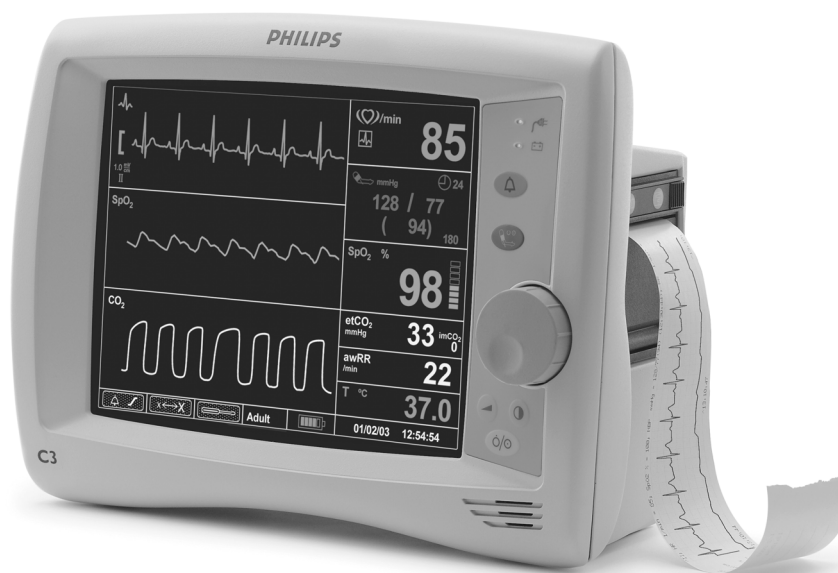
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## C3 Patient Monitor Description

The purpose and function of the C3 family of patient monitors is to monitor ECG, heart rate, non-invasive blood pressure (NBP), functional arterial oxygen saturation (SpO<sub>2</sub>), respiration rate, temperature and carbon dioxide<sup>1</sup> (CO<sub>2</sub>) for adult and pediatric patients in hospital areas and hospital-type facilities, such as clinics. The monitors may be used by clinical users during hospital transport.

The intended users of the C3 patient monitors are clinicians and nursing staffs within hospital, out-patient, and ambulatory settings. This monitor is not intended for helicopter transport or home use.

The physical and operational characteristics of the monitor are described in the **C3 Instructions for Use** guide.



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1. Carbon Dioxide monitoring is available within the C3 Sedation monitors only.

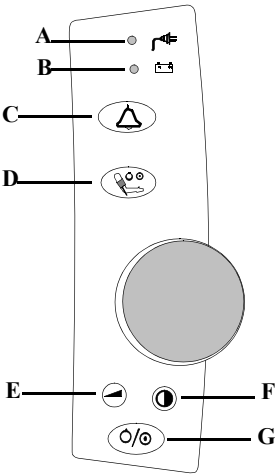
# Features and Options

The measurement parameters and features for each model are indicated below.

Order Number	Description	Display	Measurements					Printout
		Color	ECG	NBP	Temp	SpO <sub>2</sub>	CO <sub>2</sub>	Recorder
862474	Standard Color	•	•	•	•	•		(optional)
862478	Sedation Color	•	•	•	•	•	•	(optional)

## Front Panel Description

The following diagram illustrates the controls located on the front panel of your C3.

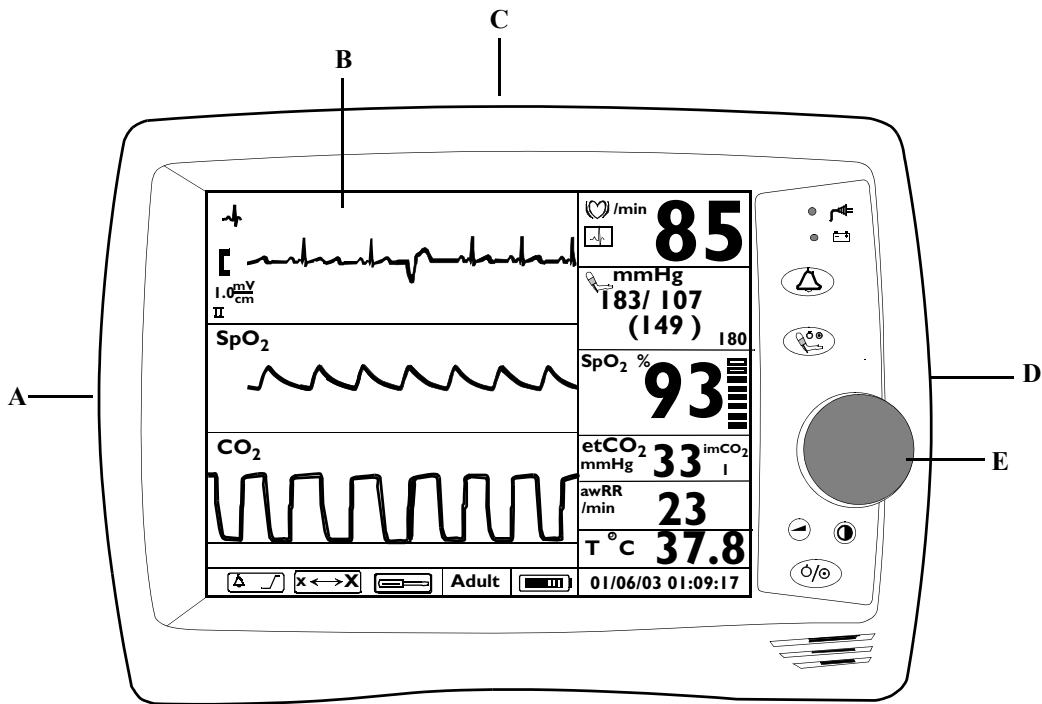


Callout	Button/LED
A.	AC LED
B.	Battery LED
C.	Audio Alarm Control button
D.	NBP button
E.	Volume button
F.	Contrast button
G.	On/Standby button



Front of Monitor

Use the following diagram to familiarize yourself with the main features of your C3 monitor. The recorder module and all patient input connectors are located on the monitor's side panels.

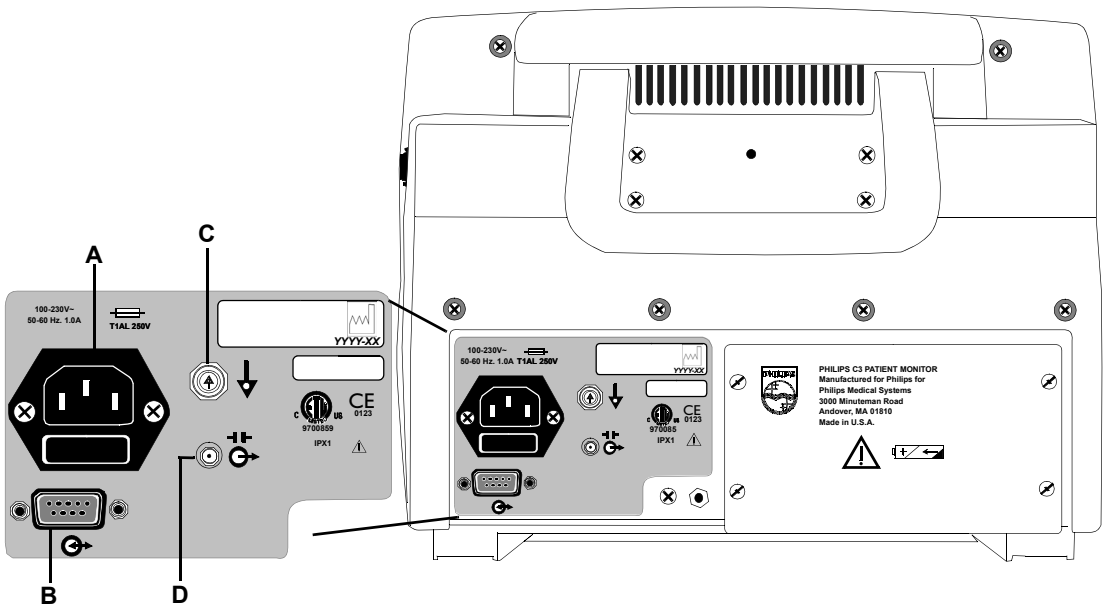





Callout	Description
A.	Patient Monitoring Input Connectors
B.	Main Monitoring Screen
C.	Handle
D.	Recorder (optional. Not available in all models)
E.	Navigation Wheel

Rear of Monitor

The following diagram is of the rear panel. For an explanation of the symbols located on this panel, see “Explanation of Symbols” on page vi.

The C3 has four connections on its rear panel. The diagram below is of the rear panel. It shows you how to make the four possible connections (Defib Sync, Equipotential, AC Input, and RS-232 I/O).



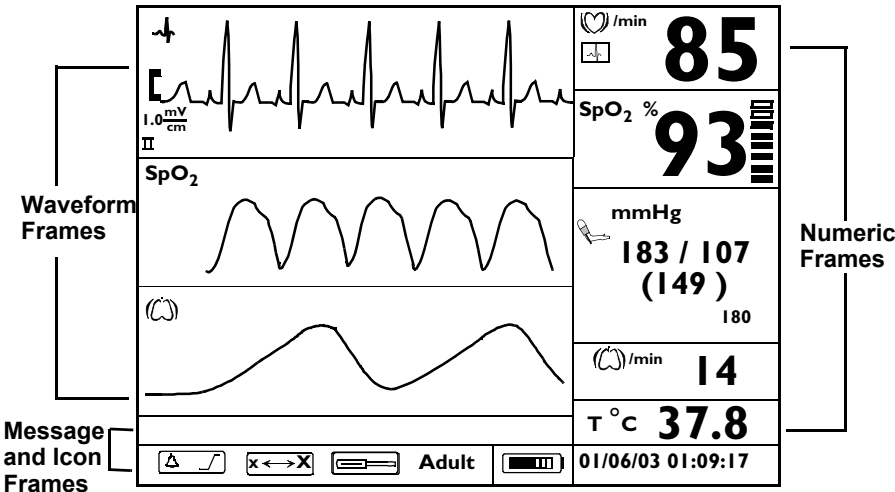
Callout	Connector	Connector Type	Label
A.	AC Input	3-line connector IEC 320 receptacle	<b>100 - 240V ~ 50 - 60Hz 1A</b>
B.	RS-232 I/O	DB-9 (male)	
C.	Equipotential Grounding Post	Equipotential  The equipotential grounding post may be used by facilities as required by their procedures.	
D.	Defib Sync	2.5mm subminiature phone jack	

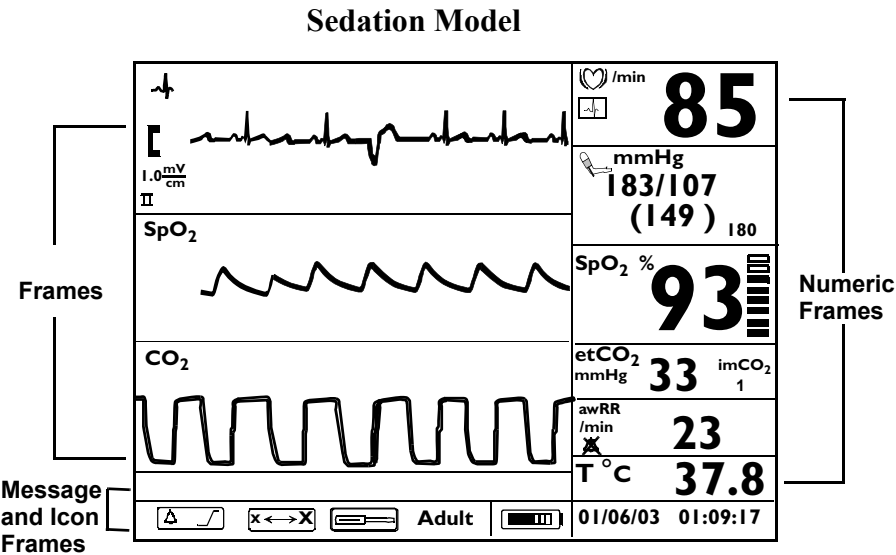
Screen Display

The LCD displays parameter values, real-time waveforms, alarm messages and screen selection icons.

- Numeric frames displays icons and numeric values of real-time physiologic parameter.
- Waveform frames displays real-time waveforms, graphical trend, or tabular trend data.
- Message and Icon frames displays alarm messages and screen selection icons.

Standard Model





## Additional Documentation

To perform test and troubleshooting procedures and to understand the principles of operation and circuit analysis sections of this manual, you must know how to operate the monitor. Refer to the **C3 Instructions For Use** guide to understand the various sensors, ECG leads, blood pressure cuffs, CO<sub>2</sub> parameters and accessories and temperature probes that work with the monitor. Instructions for cleaning and caring for the accessories can also be found in the individual Directions for Use that accompany these accessories.

# Site Preparations

This chapter describes how to perform site preparation and how to comply with safety guidelines and requirements.

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## General Site Preparation Safety Information

---

### **Warning**

---

To avoid contaminating or infecting personnel, the service environment or other equipment, make sure that equipment which has been used before has been appropriately disinfected and decontaminated.

Disconnect the monitor from the AC source by unplugging the power cable from the AC power connector located on the rear of the monitor. The On/Standby button does not disconnect the monitor from the AC mains supply

Accessory equipment connected to the monitor's data interface must be certified according to IEC Standard 60950 for data-processing equipment or IEC Standard 60601-1 for electromedical equipment. All combinations of equipment must be in compliance with IEC Standard 60601-1-1 systems requirements.

**Explosion Hazard.** Equipment not suitable for use in the presence of a flammable anaesthetic mixture with air, or with oxygen or nitrous oxide.

Make sure that you have read all applicable instructions before attempting to install the wall mount.

Wall mounts that are intended to support monitors must be capable of supporting 4 times the weight of the monitor when properly installed.

Do not mount any portion of a monitoring instrument over a patient's bed.

Do not exceed the maximum rated load specified for each wall mount.

Ensure that no electrical wiring, utilities, or piping interfere with the selected wall mounting location.

---

---

### **Note**

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Do not return sensors, patient cables, NBP tubing and cuff, or the power cord.

---

---

## Site Preparation Guidelines

- Check that the environment is reasonably free from dust, vibration, corrosive or explosive gases and is within specified temperature and humidity ranges. See *Chapter 12, "Specifications"*
- Position the monitor so that the display is clearly visible and the controls are easy to reach.

---

## Warning, Cautions and Safety Precautions

### Patient Safety

To better secure patient safety, become familiar with the details in *Chapter 12, "Specifications."*

### Patient Leakage Current

The patient leakage current is  $\leq 50\mu\text{A}$  @ 250 V. The monitor has patient input connectors (Type CF) that are protected against the effects of defibrillation and electrosurgery.

You will find the following heart symbol on the side of the monitor where the patient monitoring input connectors are located. The symbol indicates that the monitor is Type CF and is designed to have special protection against electric shocks (particularly regarding allowable leakage currents, having a F-Type applied part, according to the standards IEC 60601-1/EN60601-1/CSAC22.2 601.1/UL 2601-1), and is defibrillator proof.



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## Preparing to Use the Monitor

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**Warning**

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**To avoid contaminating or infecting personnel, the service environment or other equipment, make sure that equipment which has been used before has been appropriately disinfected and decontaminated.**

---

### Power Source Requirements

See the section titled, *“Electrical” on page 12- 3* for all electrical specifications.

### Protecting Against Electrical Shock

The C3 patient monitor is classified as Class I Equipment with an internal power source according to IEC 60601-1/CSAC22.2 601.1/UL 2601-1, which means that it is a monitor included in the protective grounding (protective earth) system of the room by way of grounding contacts in the power plug.

---

**Warning**

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**Disconnect the monitor from the AC source by unplugging the power cable from the AC power connector located on the rear of the monitor. The On/Standby button does not disconnect the monitor from the AC mains supply.**

---

### Equipotential Grounding

To eliminate potential differences between different pieces of equipment, the monitor must have a separate connection to the equipotential grounding system.

One end of the equipotential grounding cable (potential equalization conductor) is connected to the equipotential grounding post on the rear of the monitor, and the other end is connected to one point of the equipotential grounding system.

### Combining Equipment

All combinations of medical equipment with non-medical equipment must comply with IEC 60601-1-1.

---

**Warning**

---

**Accessory equipment connected to the monitor’s data interface must be certified according to IEC Standard 60950 for data-processing equipment or IEC Standard 60601-1 for electromedical equipment. All combinations of equipment must be in compliance with IEC Standard 60601-1-1 systems requirements.**

---



## Disposing of the Monitor

To avoid contaminating or infecting personnel, the environment or other equipment, make sure you disinfect and decontaminate the monitor appropriately before disposing of it in accordance with your country's law for equipment containing electrical and electronic parts.

For disposal of parts and accessories, such as ECG and SpO<sub>2</sub>, where not otherwise specified, follow local regulations regarding disposal of hospital waste.

For disposal of the lead-acid battery, follow local regulations for safe disposal of lead.

---

### **Warning**

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**Explosion Hazard. Equipment not suitable for use in the presence of a flammable anaesthetic mixture with air, or with oxygen or nitrous oxide.**

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## Unpacking the Monitor

The box comes with the following:

- the C3 Instructions for Use guide
- the C3 patient monitor
- an AC power cord

In addition, you should receive all of the accessories and options that you have ordered.

If there is anything missing, contact your Philips Medical Systems representative immediately.

---

## Checking the Shipment

Examine the carton carefully for evidence of damage in transit. If you discover any damage, contact the carrier immediately. Retain all packing material.

If you have to return the monitor, contact the Philips Response Center or your local Philips representative for shipping instructions.

To pack the monitor for return, disconnect all cables. Pack the monitor in its original shipping carton. If this is unavailable, use a suitable carton with appropriate packing material to protect the monitor during shipping.

---

### **Note**

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Do not return sensors, patient cables, NBP tubing and cuff, or the power cord.

---

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## Returning System Components

If it is necessary to return the monitor for service, call the Philips Response Center or your local Philips representative for shipping instructions. Have all equipment serial numbers available when calling.

To pack the monitor for return, disconnect all cables. It is not necessary to return sensors, patient cables, NBP tubing and cuff or power cord. Pack the monitor to be returned in its original shipping carton if available. If not, use a suitable carton with appropriate packing material to protect the monitor during shipping.

## Mounting

---

**Warning**

---

Make sure that you have read all applicable instructions before attempting to install the wall mount.

Wall mounts that are intended to support monitors must be capable of supporting 4 times the weight of the monitor when properly installed.

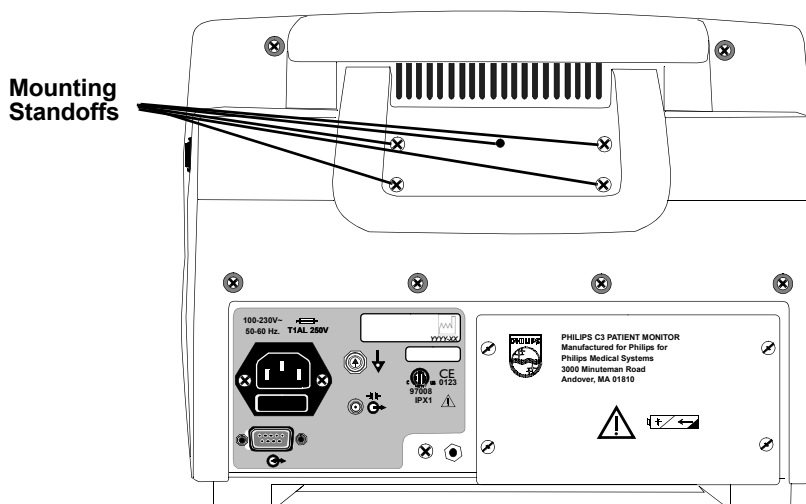
Do not mount any portion of a monitoring instrument over a patient's bed.

Do not exceed the maximum rated load specified for each wall mount.

Ensure that no electrical wiring, utilities, or piping interfere with the selected wall mounting location.

---

The rear panel includes threaded standoffs for attaching a mounting system accessory.



---

## Warnings, Cautions, and Safety Precautions Relating to Wall Mount Installation

- Make sure that you have read all applicable instructions before attempting to install the wall mount.
- Wall mounts that are intended to support monitors must be capable of supporting four times the weight of the monitor when properly installed.
- If wall mounts are to be installed on plaster board walls, we recommend that the mounts be installed using steel or plywood plates sufficient to distribute the load over a large section of the wall. **Lead expansion bolts are neither adequate nor safe for this purpose.**
- It is the responsibility of the hospital, institution, or its designated representatives to determine that the wall is adequate to safely mount monitoring instrumentation. This includes the selection of and proper installation of the appropriate fasteners and mounts. In a new construction, or in a remodelled construction where the wall can be completely or partially removed, a 16-gauge steel stud should be mounted for the purpose of attaching the wall channel. This design safety factor is based on four times (4x) the maximum rated load.
- **GCX Wall Channel:** Always reposition the adjustable channel safety stop under the adapter plate when the height of the monitor is changed.
- The channel safety stop prevents the mounting device from inadvertently falling or being pulled out of the wall channel. **Do not remove this stop while the mount is supporting a monitor.**
- Do not mount any portion of the monitor over a patient's bed.
- Do not exceed the maximum rated load specified for each wall mount.
- Ensure that no electrical wiring, utilities, or piping interface with the selected wall mounting location.
- Do not install wall channel onto solid brick or brick veneer walls. Do not attempt to install wall mounts onto crumbly wall material.
- Check the mounting hardware holding the wall channel or bracket to the wall every 12 months. Tighten if necessary.

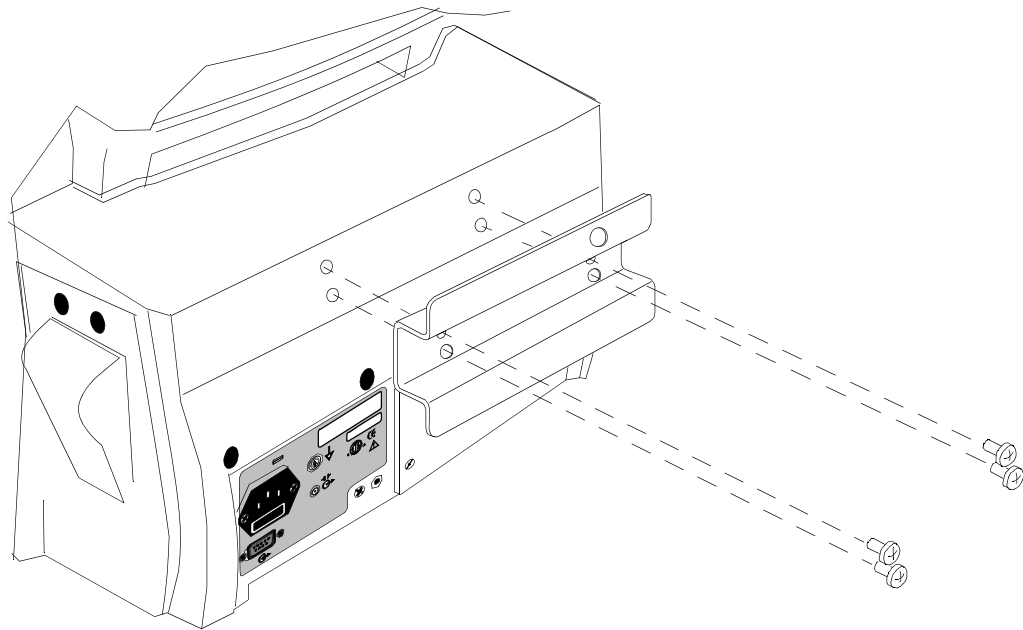
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## Mounting the GCX Wall Channel

To install the GCX Wall Channel and Tilt/Swivel mount, follow the documentation packaged with the channel.

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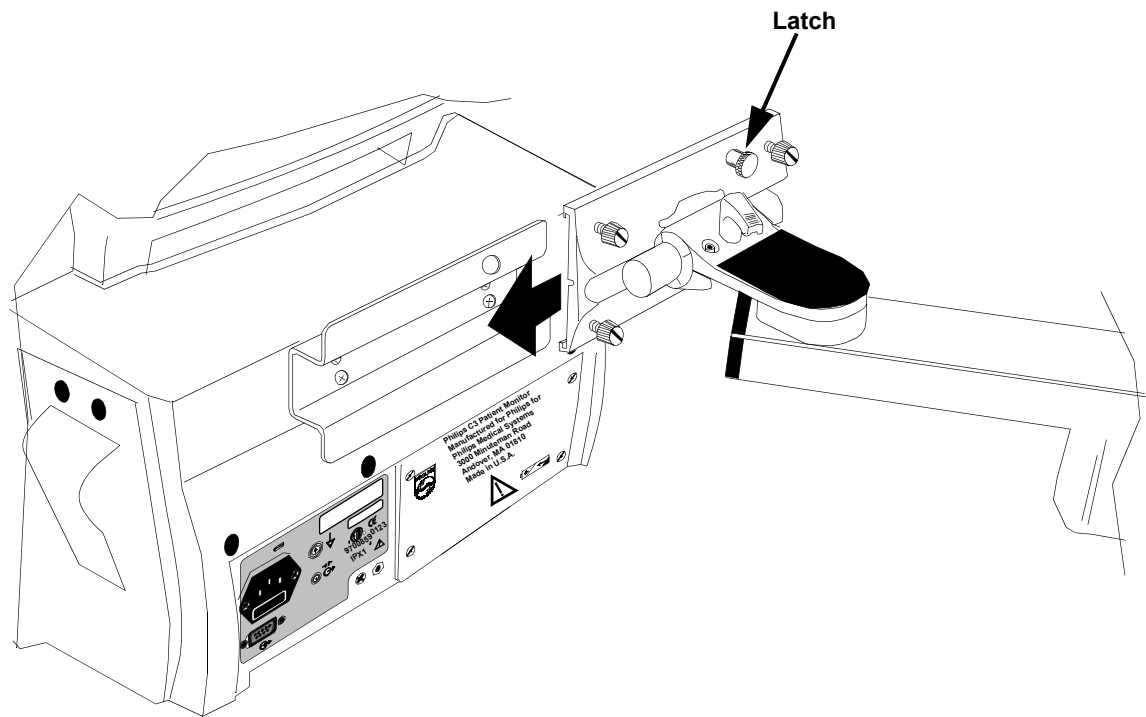
## Attaching the Mounting Plate to the Monitor



Step	Action
1	Unpack the mounting plate and check all parts are present.
2	Unscrew the 5 screws from the mounting standoffs located on the rear of the monitor.
3	Place the Wall Plate over the mounting standoffs.
4	Re-insert and tighten the screws to secure the wallplate to the monitor.

---

## Attaching the Monitor to the Wall Channel



Step	Action
1	Slide the Tilt/Swivel mount into the Wall Plate as illustrated by the above diagram.
2	Make sure the latch snaps into the hole on the upper right-hand corner of the wallplate.

# Maintaining the Monitor

This chapter describes how to clean your monitor and how to keep your monitor in the best working condition.

---

## Maintenance Safety Information

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### **Warning**

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**Follow local governing ordinances and recycling plans regarding disposal or recycling batteries and other device components.**

**If the battery shows signs of damage or signs of leakage, replace it immediately. Do not use a faulty battery in the monitor.**

**Never use a monitor that is monitoring a patient to perform battery conditioning.**

---

---

### **Caution**

---

Do not immerse the monitor in liquid or use caustic or abrasive cleaners.

Do not spray or pour any liquid on the monitor or its accessories.

Do not allow any liquid to penetrate connectors or openings in the monitor's chassis.

---



---

## Objectives

In order to meet this chapter's objectives, you should be able to perform light maintenance and preventative maintenance for the monitor through the following tasks:

- Inspection of the monitor
- Cleaning the monitor
- Battery Maintenance

---

## Concepts

### **Light Maintenance**

Light maintenance tasks can be defined as those tasks required to maintain the monitor in clean, functional working order. These include inspection, cleaning practice and battery maintenance as well as the continuous observation of replaceable parts for wear.

### **Battery Conditioning**

A rechargeable battery must be conditioned at regular intervals to prepare it for further charge/discharge cycles. Conditioning a battery refers to the complete discharge of a charged battery by allowing it to die out while in non-critical use. The empty battery may then be recharged and put back into use.

## Recommendations for Maintenance Frequency

The following table is the recommended maintenance schedule for your C3 monitor. The maintenance checklist appears in the next section of this chapter. The checklist may be photocopied and should be completed by the maintainer. It should be filed for future reference. The owner of the equipment is responsible for the performance of the maintenance activities with the schedule below.

Maintenance	Frequency	Procedure
Inspect the monitor, cables and cords	Daily	<i>"Inspecting the Monitor" on page 3-6 and "Inspecting the Cables and Cords" on page 3-6</i>
Cleaning	As needed	<i>"Cleaning" on page 3-7</i>
Safety checks according to IEC 60601-1	At least once every 2 years, after any repairs, if the monitor has been dropped or as needed.	<i>"Patient Safety Tests" on page 4-39</i>
Functional testing procedures	When functional defects in the measurements are suspected.	<i>"Functionality Assurance" on page 4-3</i>
Performance Assurance	At least once every year, or as needed (if you suspect defects in the measurements).	<i>"Performance Assurance Test" on page 4-11</i>
Replace backlight	20,000 hours (about 4 years) of continuous use, or as needed.	<i>"Replacing the Backlight Tube" on page 7-9</i>
NBP Maintenance	Every year, or as needed, if the monitor has been opened, or you suspect defects in the measurement.	<i>"Preventative Maintenance Tests" on page 4-14</i>
Battery Maintenance	Every two years	<i>"Battery Maintenance" on page 3-7</i>
Battery Conditioning	Approximately every 200 deep discharges.	<i>"Conditioning a Battery" on page 3-10</i>

---

## Maintenance Checklist

Topics	See Page....	Check Here if Completed	Date Completed
Inspect Cables, Cords and Housing	3-6		
Replacing the Backlight Tube Assembly	7-9		
NBP Preventative Maintenance	4-14		
Cleaning Guidelines	3-7		
Checking the Battery Status	3-8		
Charging the Battery	3-9		
Conditioning the Battery	3-10		
Testing the Monitor	4-1		

---

## Inspecting the Monitor

If you discover a problem while inspecting monitor, contact your biomedical department or Philips Medical Systems.

With the monitor turned Off:

Step	Action
1	Examine the exterior of the monitor for cleanliness and general physical condition. Verify that the housing is not cracked or broken, that everything is present, that there are no spilled liquids and that there are no signs of abuse.
2	Inspect all accessories (cables and sensors) external to the monitor, referring to the accessories' documentation.
3	Switch the monitor On and verify that the backlight is bright enough. Check that screen is at its full brightness. If the brightness is not adequate, contact your biomedical department. Philips Medical Systems recommends replacing the backlight about every 4 years.
4	If you are operating the monitor from battery, verify that the battery is adequately charged before you begin use.

---

## Inspecting the Cables and Cords

If you discover a problem while inspecting the cables and cords, replace the cable, or contact your biomedical department.

Step	Action
1	Examine the power plug and cord for damage. Make sure that the prongs of the plug do not move in the casing. If damaged, replace the entire cord with the appropriate Philips power cord.
2	Inspect the patient cables and leads and their strain reliefs for general condition. Make sure there are no breaks in the insulation. Make sure that the connectors are properly engaged at each end to prevent rotation or other strain.
3	With the sensor or electrodes applied to the patient, and the monitor turned On, flex the patient cables near each end to make sure that there are no intermittent faults.

---

## Cleaning

---

### Caution

---

Do not immerse the monitor in liquid or use caustic or abrasive cleaners.

Do not spray or pour any liquid on the monitor or its accessories.

Do not allow any liquid to penetrate connectors or openings in the monitor's chassis.

---

To clean the monitor, dampen a cloth with a commercial, nonabrasive cleaner and wipe the top, bottom, and front surfaces lightly. For cables, sensors and cuffs, follow the cleaning instructions in the Directions for Use shipped with those components.

If liquid is accidentally spilled on the monitor, clean and dry it thoroughly before reuse.

If in doubt about monitor safety, refer the unit to qualified service personnel.

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## Battery Maintenance

This section provides some information on how to handle and maintain the battery.

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### Warning

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**Follow local governing ordinances and recycling plans regarding disposal or recycling batteries and other device components.**

---

### About the Battery

Storing the monitor for a long period of time without charging the battery can degrade the battery capacity. A complete battery recharge (>90%) requires 8 hours in standby mode or 14 hours in operational mode. If the battery needs charging, connect the monitor to the AC outlet as described “*Charging the Battery*” on page 3-9

If the monitor operates for less than one hour on battery power before the low battery alarm occurs, the battery should be conditioned. See “*Electrical*” on page 12-3 for typical battery operating times and conditions.

If the same symptom persists after the battery is conditioned and indicating a full charge, the battery should be replaced (see “*Removing the Battery*” on page 7-4 for more information).

## Battery Guidelines

To get the most out of the battery, observe the following guidelines:

- The shelf-life of a fully charged battery is about 6 months.
- After a battery has been activated, keep it charged. If it is not in use, recharge it every 3 to 4 months.
- Condition the battery approximately every 200 deep discharges.
- Remove the battery from the monitor if it is not being used regularly. (Leaving the battery in a monitor that is not in regular use using the battery will shorten the life of the battery).
- Battery Disposal - We recommend replacing the monitor's sealed, lead-acid battery at 2 year intervals. Follow local governing ordinances and recycling plans regarding disposal or recycling of batteries and other device components.
- Do not dispose of the battery in normal waste containers.

---

### **Warning**

---

**If the battery shows signs of damage or signs of leakage, replace it immediately. Do not use a faulty battery in the monitor.**

---

## Checking the Battery Status

When the monitor is connected to the AC (mains) power supply, the battery charges automatically.

Battery status is indicated several ways:

- LEDs on the front panel of the monitor.
- Battery gauge on the monitor's main monitoring screen.
- INOP messages

The AC LED is only on when the power cord is connected and the AC power is available to the monitor. In this case, the battery can be either charging or fully charged.

## Identifying Battery Strength

You can determine the monitor's battery strength by the color of the battery icon, or by the number of illuminated bars on the battery icon. The following table describes the battery icon behavior:

Number of Bars Illuminated	Color Used	Behavior
3, 4, or 5	Green	Constant display
2	Yellow	Constant display
1	Red	Constant display
0	Red	Battery icon flashes and message displays

- If the battery operating time is less than 30 minutes, the battery icon flashes. A low priority audio alarm sounds (1 beep every 4 seconds).
- When the battery is empty, a "Low Battery" INOP message displays in the Message frame and the audible alarm sounds. Pressing any front panel button clears the INOP and silences the audible alarm. The battery icon continues to flash until the monitor is powered down or automatically switches off.

If the new battery is partly or fully charged, the monitor starts operating.

## Charging the Battery

A complete battery recharge (>90%) requires 8 hours in standby mode or 14 hours in operational mode.

To charge the battery:

Step	Action
1	Connect the monitor to the AC power source using the proper power cord.
2	Verify that the AC Input Indicator LED is lit.
3	Charge the battery for at least 8 hours. The battery may require a full discharge/charge cycle to restore it to its normal capacity.
4	To check for a full charge, perform the procedure described in <i>"Battery Performance Test"</i> on page 4-22.

## Conditioning a Battery

Battery conditioning re-calibrates the battery to ensure that it has accurate information on the actual battery capacity.

---

**Warning**

---

**Never use a monitor that is monitoring a patient to perform battery conditioning.**

---

## Why is Battery Conditioning Necessary?

The capacity of a battery decreases gradually over the lifetime of the battery. Each time a battery is charged its capacity decreases slightly. Therefore, the operating time of a monitor running off the battery also decreases with each charge cycle.

Battery conditioning ensures that the value stored in the battery for its fully capacity takes account of this decrease, so that the remaining battery charge can be calculated accurately, and the low battery warning given at the right time.

## When Should Battery Conditioning be Performed?

Battery conditioning should be performed:

- Every 200 deep discharge cycles.

## How to Condition a Battery

We recommend two full charge and discharge cycles to ensure proper conditioning, independent of the initial condition of the battery.

If you need to continue battery powered monitoring, replace the battery in the monitor with a different charged and conditioned battery. You cannot condition a battery in a monitor that is being used.

Step	Action
1	Insert the battery that is to be conditioned into a monitor that is not currently being used.
2	Disconnect the monitor from the AC power supply.
3	Turn on the monitor, and leave it on until it switches off automatically.
4	Turn the monitor Off using the <b>On/Standby</b> button located on the front panel.
5	Reconnect the monitor the AC power supply.
6	Charge the battery until it is full. (When you turn the monitor On, the 5 bars in the battery gauge on the main monitoring screen will be illuminated).
7	Repeat steps 2 to 6.



## **Battery INOP Messages**

The following battery-related INOP messages are issued by the monitor. All Battery INOPs continue until the monitor is plugged into the AC power or the INOP condition is fixed.

- "Low Battery" - This is an INOP which indicates that the remaining battery-operating time is less than approximately 30 minutes.



# Testing the Monitor

This chapter provides a checklist of testing procedures used to verify performance following repairs or during routine maintenance. All tests can be performed without removing the monitor's covers.

If the monitor fails to perform as specified in any test, repairs must be done to correct the problem before the monitor is returned to the user.

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## Testing Safety Information

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### **Warning**

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**Perform all leakage tests any time the unit is opened.**

**AC mains voltage is present on the applied part terminals during this test. Exercise caution to avoid electrical shock hazard.**

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### **Note**

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The monitor must be placed in **Diagnostic Mode**, with the NBP test screen active for each of the NBP tests.

If the test fails, ensure the integrity of the cuff and tubing, then test again. If the test fails again, verify the integrity of all the pneumatic tubing inside the monitor.

Before beginning the Battery Performance test, ensure that the monitor is disconnected from the AC power source.

---

## Objectives

In order to meet this chapter's objectives, you should be able to test the monitor through the following types of tests:

- Performance Assurance Check List
- Accuracy, Calibration and Performance Procedures
- Patient Safety Checks

For inspection procedures; preventative maintenance procedures; cleaning procedures; and battery maintenance, refer to this chapter and *Chapter 2, "Site Preparations"*.

---

## Concepts

### Functionality Assurance

This refers to the combined Performance Assurance Test and Functionality Testing Procedures found in this chapter. These tests verify correct monitor functionality in general terms.

### Preventative Maintenance

Preventative Maintenance refers specifically to the service calibration tests required to ensure the monitor measurement results are accurate. When authorized Philips personnel service the monitor, they report these results back to Philips. The collected data forms a database to be used in product development. These specific tests are required for the NBP parameter. It is not necessary for hospital personnel to report results.

### Performance and Safety Tests

This concept refers to all the remaining accuracy and performance tests available on the monitor, including safety tests and checks for the monitor.

## Testing Checklist

The tests described in this chapter are listed in the table below. Use this table as a checklist.

Topics	See...	Check Here if Completed	Date Completed
<b>Functionality Assurance Tests</b>			
Performance Assurance Test	<i>page 4-11</i>		
Power-On Self-Test	<i>page 4-11</i>		
Alarm Test	<i>page 4-12</i>		
Volume Control Test	<i>page 4-12</i>		
<b>Preventive Maintenance Tests</b>			
NBP	<i>page 4-14</i>		
<b>Performance Procedures</b>			
Battery Performance Test	<i>page 4-22</i>		
Temperature Test	<i>page 4-23</i>		
ECG Performance	<i>page 4-25</i>		
Respiration Performance	<i>page 4-25</i>		
SpO <sub>2</sub> Performance	<i>page 4-27</i>		
CO <sub>2</sub> Performance	<i>page 4-29</i>		
Serial Interface and Nurse Call Signal Test	<i>page 4-36</i>		
ECG Sync Performance Test	<i>page 4-38</i>		
<b>Patient Safety Tests</b>			
S(1) Ground Integrity	<i>page 4-39</i>		
S(2) Electrical Leakage	<i>page 4-41</i>		
S(3) Earth Leakage Current	<i>page 4-41</i>		
S(4) Enclosure Leakage Current	<i>page 4-42</i>		
S(5) Patient Leakage Current	<i>page 4-43</i>		
S(6) Patient Leakage Current with Mains	<i>page 4-44</i>		

## Test Reporting

The following table shows what must be recorded on the Service Record after completing the tests in this chapter.

Test	What to Record
<b>Functionality Assurance Tests</b>	
Visual	V:P or V:F
Power On	PO:P or PO:F
<b>Preventive Maintenance Tests</b>	
<b>P NBP</b>	PN:P/X1/X2/X3/X4/X5 or PN:F/X1/X2/X3/X4/X5 See page 4-15 for details
<b>Performance Procedures</b>	
<b>CO<sub>2</sub></b> Performance	PCO <sub>2</sub> : P/X1/X2/X3/X4/X5/X6/X7 or PCO <sub>2</sub> : F/X1/X2/X3/X4/X5/X6/X7 See page 4-30 for details
<b>Patient Safety Tests</b>	
Safety(1) Ground Integrity	S(1):P or S(1):F
Safety(2) Earth Leakage Current	S(2):P or S(2):F
Safety(3) Enclosure Leakage Current	S(3):P or S(3):F
Safety(4) Patient Leakage Current	S(4):P or S(4):F
Safety(5) Patient Leakage Current with Mains	S(5):P or S(5):F

Where P = Pass, F = Fail and X is the measured value as defined in the tests described in this chapter.

## Recommendations for Testing Frequency

The testing checklist appears in the next section of this chapter. Perform the procedure as indicated in the suggested testing timetable. These timetable recommendations do not supersede local requirements.

Suggested Testing	Frequency
Functionality Assurance <ul style="list-style-type: none"> <li>• Performance Assurance Test</li> <li>• System Self-Test</li> </ul>	When functional defects in the measurements are suspected, after any repairs, if the monitor has been dropped or opened.
Preventative Maintenance Tests (NBP)	Every year, or as needed.
Performance Tests <ul style="list-style-type: none"> <li>• Battery Performance</li> <li>• Temperature Accuracy</li> <li>• ECG Performance</li> <li>• Resp Performance</li> <li>• SpO<sub>2</sub> Performance</li> <li>• CO<sub>2</sub> Performance</li> <li>• Serial Interface and Nurse Call Signal Test</li> <li>• ECG Sync Performance<sup>a</sup></li> </ul>	The battery performance test must be performed every two years, before monitor repairs, or whenever the battery is suspected as being the source of the problems.  All other test must be performed at least once every year, if the monitor has been opened, or if you suspect defects in the measurements.
Safety Checks (in accordance with IEC 60601-1) <ul style="list-style-type: none"> <li>• Ground Integrity</li> <li>• Electrical Leakage</li> <li>• Earth Leakage Current</li> <li>• Enclosure Leakage Current</li> <li>• Patient Leakage Current</li> <li>• Patient Leakage Current with Mains Voltage on the Applied Part</li> </ul>	At least once every 2 years, after any repairs, if the monitor has been dropped or opened.

a. Only when in use as part of hospital protocol safety checks.



## Test Map

The Test Map shows which tests are required in which situations.

<b>Service Event (When performing...)</b>	<b>Test Block Required (...complete these test)</b>
Installation	<ul style="list-style-type: none"> <li>• Visual</li> <li>• Power On</li> </ul>
Monitor exchange	<ul style="list-style-type: none"> <li>• Visual</li> <li>• Power On</li> </ul>
Monitor opened	<ul style="list-style-type: none"> <li>• Power On</li> <li>• Pneumatic Leakage Test</li> <li>• All Safety tests</li> </ul>
Battery replacement	<ul style="list-style-type: none"> <li>• Power On</li> <li>• Battery Performance</li> <li>• All Safety tests</li> </ul>
Speaker replacement	<ul style="list-style-type: none"> <li>• Power On</li> <li>• Pneumatic Leakage Test</li> <li>• All Safety tests</li> </ul>
Backlight tube replacement	<ul style="list-style-type: none"> <li>• Power On</li> <li>• Pneumatic Leakage Test</li> <li>• All Safety tests</li> </ul>
NBP pump replacement	<ul style="list-style-type: none"> <li>• Power On</li> <li>• Pneumatic Leakage Test</li> <li>• All Safety tests</li> <li>• Preventative Maintenance Tests</li> </ul>
SpO <sub>2</sub> module replacement	<ul style="list-style-type: none"> <li>• Power On</li> <li>• Pneumatic Leakage Test</li> <li>• All Safety tests</li> <li>• SpO<sub>2</sub> Tests</li> </ul>
CO <sub>2</sub> module replacement	<ul style="list-style-type: none"> <li>• Power On</li> <li>• Pneumatic Leakage Test</li> <li>• All Safety tests</li> <li>• CO<sub>2</sub> Tests</li> </ul>
Power supply module replacement	<ul style="list-style-type: none"> <li>• Power On</li> <li>• Pneumatic Leakage Test</li> <li>• Safety Tests</li> </ul>
Patient monitoring I/O module replacement	<ul style="list-style-type: none"> <li>• Power On</li> <li>• Pneumatic Leakage Test</li> <li>• All Safety tests</li> <li>• All Performance tests</li> </ul>
Communications module replacement	<ul style="list-style-type: none"> <li>• Power On</li> <li>• Pneumatic Leakage Test</li> <li>• All Safety tests</li> </ul>

## Equipment

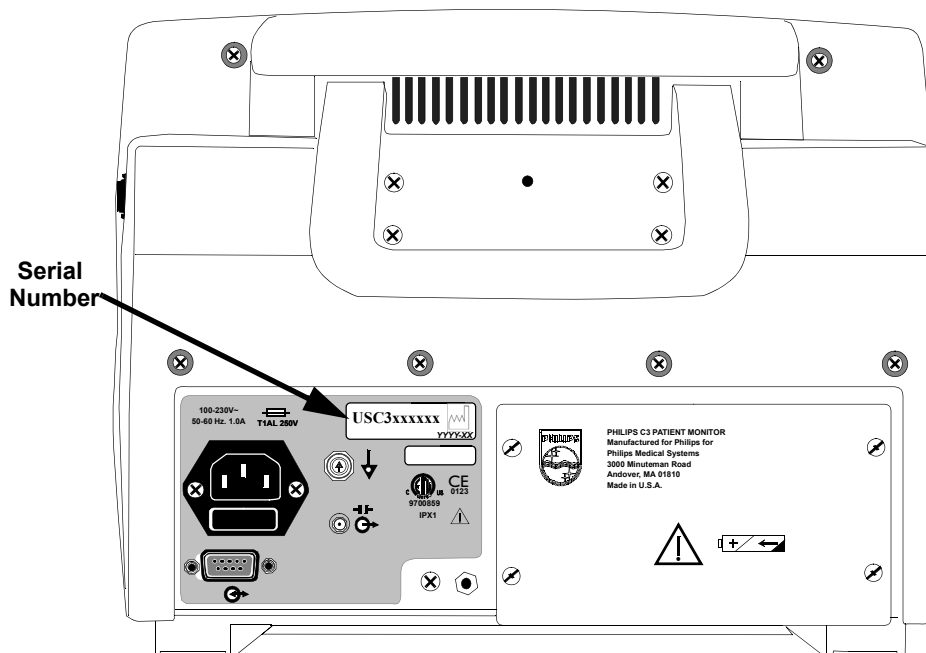
The following table lists the equipment required for performance verification.

Equipment	Description
Digital multimeter (DMM)	Fluke model 87 or equivalent
Defib Sync Cable and Switchcraft 3.5 mm phone plug	M4820A (see page 4-38 to use a substitute cable) Switchcraft 750 or equivalent
SpO <sub>2</sub> adapter cable	M1943A
SpO <sub>2</sub> reusable sensor, adult finger	M1191A
ECG trunk cable	M1540C (ICU, AAMI) or M1550C (ICU, IEC)
ECG electrodes	Standard
ECG lead sets	M1605A (AAMI) or M1615A (IEC)
NBP tubing	M1599B
NBP reusable cuff, adult	40401C
Pulse oximeter tester	Clinical Dynamics Corp - SmartSat simulator with Nellcor simulator cable
ECG simulator	Dynatech Nevada medSim 300 or equivalent
NBP simulator	Bio-Tek BP Pump 2 or equivalent
Temperature simulator	MedSim 300 or equivalent
Respiration simulator	MedSim 300 or equivalent
Safety analyzer	Bio-Tek 601 Pro or equivalent
Stopwatch	Manual or electronic
Screwdriver	flathead and philips
Tweezers	any model
Electronic flowmeter	M1026-60144
Cal 1 gas (5% CO <sub>2</sub> )	15210-64010
Cal 2 gas (10% CO <sub>2</sub> )	15210-64020
Cal gas flow regulator	M2267A
Cal tube	13907A

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## Serial Numbers

When recording test results, these are always associated with a particular monitor by means of the serial number. The serial number is 10 characters and is located on the back of the monitor.



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## Passwords

Some of the test may require that you enter the **Power-Up Default Menu** located in the **Setup Menu**. To access **Power-Up Default Menu** you must enter a password. The password is:

2 - 1 - 5

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## Visual Test

Inspect the system for obvious signs of damage. Also check external leads and accessories.

What to record on the service record:

V:P or V:F

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## Power On Test

Step	Action
1	Switch the monitor On.
2	Observe whether the system boots up successfully without displaying any error codes. The main monitoring screen should display.

What to record on the service record:

PO:P or PO:F

## Functionality Assurance Tests

The following assurance checks are recommended to verify proper operation daily before the monitor is used to monitor a patient.

During functionality assurance checks, verify the overall operation by completing the following Performance Assurance Tests.

### Performance Assurance Test

To verify your monitor works properly, perform the following test:

Step	Action
1	Using the supplied AC power cord, connect the monitor to the AC power source.
2	Verify that the AC LED is lit.
3	Do not connect any patient monitoring input connectors or cables to the monitor. If there are any such connections, disconnect them.
4	<p>If the monitor is Off, press the <b>On/Standby</b> button. The monitor must perform the following sequence:</p> <ul style="list-style-type: none"> <li>a. The screen backlight illuminates.</li> <li>b. Three consecutively higher pitched "chimes" sound while the version numbers of the boot and operational software display.</li> <li>c. After successful completion, the main monitoring screen displays. No vital sign numeric values or waveforms display.</li> </ul>
5	If any error codes display, or the screen remains blank, refer to <i>Chapter 6, "Troubleshooting"</i> .

### Power-On Self-Test

After you first press the **On/Standby** button, the monitor displays a startup screen and conducts a set of self-diagnostic test routines.

## Alarm Test

### Tools Needed:

- SpO<sub>2</sub> adapter cable (M1943A)
- Clinical Dynamics Corp - SmartSat simulator (with Nellcor simulator cable)

Step	Action										
1	Connect SpO <sub>2</sub> simulator cable to the SpO <sub>2</sub> adapter cable. Connect the cable to the SpO <sub>2</sub> patient monitoring input connector.										
2	Set the simulator as follows: <table> <tr> <th>Item</th><th>Setting</th></tr> <tr> <td>Oximeter</td><td>Nellcor</td></tr> <tr> <td>SpO<sub>2</sub>%</td><td>81</td></tr> <tr> <td>BPM</td><td>36</td></tr> <tr> <td>Pulse Mod</td><td>0.50%</td></tr> </table>	Item	Setting	Oximeter	Nellcor	SpO <sub>2</sub> %	81	BPM	36	Pulse Mod	0.50%
Item	Setting										
Oximeter	Nellcor										
SpO <sub>2</sub> %	81										
BPM	36										
Pulse Mod	0.50%										
3	Press the <b>On/Standby</b> button to turn the monitor On.										
4	After the normal power-up sequence, verify that the SpO <sub>2</sub> % display initially indicates zero, or is blank.										
5	Verify that the following monitor reaction occurs: <p>a. After approximately 45 seconds, the monitor displays saturation and heart rate as specified by the tester. Verify that the values are within the following tolerances:</p> <ul style="list-style-type: none"> <li>– Oxygen Saturation Range 79% to 83%</li> <li>– Heart Rate Range 33 to 39 bpm</li> </ul> <p>b. The audible alarm sounds and both the SpO<sub>2</sub>% and Heart Rate (HR) displays flash, indicating both parameters have violated the default alarm limits.</p> <p>c. The HR tone is heard. For this test, the HR tone source must be set to SpO<sub>2</sub> from the <b>Heart Rate Menu</b>.</p>										
6	Press the <b>Alarm Silence</b> button to temporarily silence the audible alarm.										
7	Verify the following: <p>a. The audible alarm remains silenced.</p> <p>b. The crossed-out bell icon displays in each numeric frame on the screen.</p> <p>c. The SpO<sub>2</sub>% and HR displays continue flashing.</p> <p>d. The HR tone remains audible.</p> <p>e. The audible alarm returns in approximately 120 seconds.</p>										

## Volume Control Test

### Tools Needed:

- SpO<sub>2</sub> adapter cable (M1943A)
- Clinical Dynamics Corp - SmartSat simulator (with Nellcor simulator cable)

Step	Action										
1	Connect SpO <sub>2</sub> simulator cable to the SpO <sub>2</sub> adapter cable. Connect the cable to the SpO <sub>2</sub> patient monitoring input connector.										
2	<p>Set the simulator as follows:</p> <table> <tr> <th>Item</th><th>Setting</th></tr> <tr> <td>Oximeter</td><td>Nellcor</td></tr> <tr> <td>SpO<sub>2</sub>%</td><td>81</td></tr> <tr> <td>BPM</td><td>70</td></tr> <tr> <td>Pulse Mod</td><td>5.00%</td></tr> </table>	Item	Setting	Oximeter	Nellcor	SpO <sub>2</sub> %	81	BPM	70	Pulse Mod	5.00%
Item	Setting										
Oximeter	Nellcor										
SpO <sub>2</sub> %	81										
BPM	70										
Pulse Mod	5.00%										
3	<p>a. Power the monitor On. Verify that the values are within the following tolerances:</p> <ul style="list-style-type: none"> <li>– Oxygen Saturation Range 79% to 83%</li> <li>– Heart Rate Range 67 to 73 bpm</li> </ul>										
4	Press the <b>Alarm Silence</b> button to temporarily silence the audible alarm.										
5	Verify that the heart rate tone source, found in the <b>Heart Rate Menu</b> , is set to SpO <sub>2</sub> .										
6	Press the <b>Volume</b> button on the monitor's front panel. Within 3 seconds of having pressed the button, rotate the navigation wheel clockwise to verify that the beeping heart rate tone sound level increases.										
7	<p>Wait 3 seconds. Press the <b>Volume</b> button and rotate the wheel counter-clockwise and verify that the beeping heart rate tone decreases until it is no longer audible. Rotate the wheel clockwise to return the beep volume to a comfortable level.</p> <p>After 3 seconds with no wheel activity, the volume adjust function terminates.</p>										

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## Preventative Maintenance Tests

Preventative maintenance refers specifically to the service tests required to make sure the monitor measurement results accurate. In cases where the performance of NBP is in question or could have been configured during repair, the complete set of NBP tests described in this service manual should be used.

The tests in this section verify the functionality of the monitor's pneumatic system. All of these tests, with the exception of the Basic Pneumatic Leakage (BPL) Test, require the use of an NBP simulator.

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### Note

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The monitor must be placed in **Diagnostic Mode**, with the NBP test screen active for each of the NBP tests. To place your monitor into this mode see page 4-9.

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### Tools Needed for NBP Testing:

- NBP cuff (40401C)
- NBP tubing (M1599B)
- Bio-Tek BP Pump 2 simulator or equivalent, with an internal test volume of 310 ml.



## Documenting NBP Test Results

The following table lists the tests that should be documented and summarizes how to document the NBP test results.

Test	Expected Test Results	What to record on service record
Pressure Transducer Accuracy Test	X1 = difference between the pressure on the monitor and on the simulator  Difference less than or equal to 5 mmHg (0.7 kPa)	PN:P/X1/X2/X3/X4/X5  or PN:F/X1/X2/X3/X4/X5
Pneumatic Leakage Test	X2 = difference between the pressure at the start (P1) and after one minute (P2)  Difference less than or equal to 6 mmHg (0.8 kPa)	P = passed, F = failed
Inflation Rate Test	X3 = number of seconds for the monitor to inflate  Rate between 1 and 6 seconds	
Over-Pressure Test	X4 = peak value  Peak value between 270 and 330 mmHg (36 kPa and 44 kPa)	
Deflation Rate Test	X5 = mmHg (kPa) per second to deflate  1.8 mmHg/s to 4.8 mmHg/s	

## Pneumatic System Functionality

The following tests must be performed to verify pneumatic system functionality. Perform these tests in the following order:

1. Pressure Transducer Accuracy
2. Pneumatic Leakage
3. Inflation Rate
4. Over-Pressure
5. Deflation Rate

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### Note

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The pneumatic system includes an over-pressure safety limit function and a safety period time-out function. These safety functions may interfere with NBP tests described in this section. In order to avoid activating these safety functions, do not pressurize the system above 270 mmHg (36 kPa) and do not pressurize the system for time periods that exceed 150 seconds.

---

## To Zero the Simulator

If the simulator does not display a "0" before starting a test, use the following procedure to zero the simulator:

1. Disconnect the hose from the simulator.
2. Press **Home**.
3. Press **SETUP**.
4. Press **MORE**.
5. Press **MORE** again.
6. Press **ZERO PRESSURE**.
7. Press **ZERO**.
8. Press **Home** to return to main menu.
9. Reconnect the hose.

Before beginning the above test sequence, perform the following three steps:

Step	Action
1	Turn the NBP simulator On.
2	Perform the following sequence: <ol style="list-style-type: none"> <li>a. Press the <b>Home</b> button.</li> <li>b. Press the <b>Pressure Tests</b> button.</li> <li>c. Press the <b>Pressure Leak Test</b> button.</li> <li>d. Press the <b>Setup</b> button.</li> <li>e. Press <b>2, 5, 0</b>, then Enter.</li> <li>f. Set the Cuff to <b>Internal</b>.</li> </ol>
3	Connect the simulator tubing to the NBP patient monitoring input connector.
4	Place the monitor in <b>Diagnostic Mode</b> with the NBP test screen active.

### Pressure Transducer Accuracy Test

This test verifies the pressure accuracy of the monitor's pressure transducer.

Step	Action
1	Confirm that the simulator displays "Leak Test" (see steps 1 and 2, in the previous table).
2	Press the <b>Volume</b> button to ensure that both valves are closed.
3	Perform an offset adjustment so that the simulator and monitor both display a pressure of 0 mmHg or kPa by doing the following: a. Press the <b>Contrast</b> button on the monitor's front panel. b. If needed, zero the simulator (see "To Zero the Simulator" on page 4-16).
4	Press <b>Start</b> on the simulator.
5	Allow 15-20 seconds for the pressure to stabilize. The pressure displayed on the monitor and on the simulator should be within 5 mmHg (0.7 kPa) of one another. Document the difference between the simulator value and the monitor value (X1).
6	Press the <b>Stop</b> button on the simulator to stop the test.
7	Press and hold the <b>Volume</b> button until the monitor displays a pressure of 0 mmHg or kPa.
8	If no further NBP tests are to be conducted, turn the monitor Off. Normal monitoring operation returns the next time the monitor is turned On.

### Pneumatic Leakage Test

This test verifies the integrity of the pneumatic system.

Step	Action
1	Turn the simulator on.
2	Perform the following sequence: a. Press the <b>Home</b> button. b. Press the <b>Pressure Tests</b> button. c. Press the <b>Pressure Leak Test</b> button. d. Press the <b>Setup</b> button. e. Press <b>3, 0, 0</b> , then <b>Enter</b> . f. Set the <b>Cuff</b> to <b>Internal</b> .
3	Confirm that the simulator test screen is active and displays "Leak Test".
4	Press the <b>Volume</b> button to ensure that both valves are closed.
5	Perform an offset adjustment so that the simulator and monitor both display a pressure of 0 mmHg or kPa by doing the following: a. Press the <b>Contrast</b> button on the monitor's front panel. b. If needed, zero the simulator (see "To Zero the Simulator" on page 4-16).
6	Press the <b>NBP</b> button on the monitor's front panel to activate the pump. Hold the button until the monitor displays a pressure of approximately 250 mmHg (33.3 kPa).
7	Allow 15-20 seconds for the pressure to stabilize. Record the pressure displayed on the monitor (P1).

Step	Action
8	Start a one minute timer. After one minute, record the pressure displayed again (P2). The pressure should drop by no more than 6 mmHg (0.8 kPa) during the one minute period. Calculate (P1 - P2) and document the leakage test value (X2).
9	Press and hold the <b>Volume</b> button until the monitor displays a pressure of 0 mmHg or kPa.
10	If no further NBP tests are to be conducted, turn the monitor Off. Normal monitoring operation returns the next time the monitor is turned On.

### Inflation Rate Test

This test verifies the inflation rate of the monitor.

Step	Action
1	Turn the simulator on.
2	Perform the following sequence: a. Press the <b>Home</b> button. b. Press the <b>Pressure Tests</b> button. c. Press the <b>Pressure Leak Test</b> button. d. Press the <b>Setup</b> button. e. Press <b>3, 0, 0</b> , then <b>Enter</b> . f. Set the <b>Cuff</b> to <b>Internal</b> .
3	Press the <b>Volume</b> button to ensure that both valves are closed.
4	Perform an offset adjustment so that the simulator and monitor both display a pressure of 0 mmHg or kPa by doing the following: a. Press the <b>Contrast</b> button on the monitor's front panel. b. If needed, zero the simulator (see "To Zero the Simulator" on page 4-16).
5	Press the <b>NBP</b> button on the monitor's front panel to activate the pump, and simultaneously start the timer. Hold the button until the monitor displays a pressure of 250 mmHg (33.3 kPa), then stop the timer. The inflation rate should be between 1 and 6 seconds. Document the number of seconds (X3).
6	Press and hold the <b>Volume</b> button until the monitor displays a pressure of 0 mmHg or kPa.
7	If no further NBP tests are to be conducted, turn the monitor Off. Normal monitoring operation returns the next time the monitor is turned On.

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#### Note

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The over-pressure relief may activate and automatically deflate the cuff. For more information on the NBP safety functions, see page 4-16.

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**Over-Pressure  
Test**

This test verifies the functionality of the over-pressure relief system of the monitor.

Step	Action
1	Turn the simulator on.
2	Perform the following sequence: a. Press the <b>Home</b> button. b. Press the <b>Pressure Tests</b> button. c. Press the <b>Pressure Relief</b> button. d. Press the <b>Setup</b> button. e. Press <b>3, 3, 5</b> , then <b>Enter</b> .
3	Confirm that the simulator is active and displays "Relief Valve Test".
4	Press the <b>Volume</b> button to ensure that both valves are closed.
5	Perform an offset adjustment so that the simulator and monitor both display a pressure of 0 mmHg or kPa by doing the following: a. Press the <b>Contrast</b> button on the monitor's front panel. b. If needed, zero the simulator (see "To Zero the Simulator" on page 4-16).
6	Press the <b>Start</b> button on the simulator. The peak value (X4) shown on the simulator should be between 270 mmHg and 330 mmHg (35.9 kPa and 43.9 kPa). The pressure should return to 0 automatically on the monitor and simulator). Both conditions should be true for the monitor to pass this test.
7	If no further NBP tests are to be conducted, turn the monitor Off. Normal monitoring operation returns the next time the monitor is turned On.

**Deflation Rate Test**      This test verifies the deflation rate of the monitor.

Step	Action
1	Turn the simulator on.
2	Perform the following sequence: a. Press the <b>Home</b> button. b. Press the <b>Pressure Tests</b> button. c. Press the <b>Pressure Leak Test</b> button. d. Set the <b>Cuff</b> to <b>Internal</b> .
3	Confirm that the simulator is active and displays "Leak Test".
4	Press the <b>Volume</b> button to ensure that both valves are closed.
5	Perform an offset adjustment so that the simulator and monitor both display a pressure of 0 mmHg or kPa by doing the following: a. Press the <b>Contrast</b> button on the monitor's front panel. b. If needed, zero the simulator (see "To Zero the Simulator" on page 4-16).
6	<b>Note</b> —Complete steps 6-9 within 150 seconds.  Press and hold the <b>NBP</b> button on the monitor's front panel and inflate to 250 $\pm$ 10. Don't go over 270, or safety deflation may occur. (Slow the inflation rate by pulsing the button when the pressure is over 200).
7	Allow 15-20 seconds for the pressure to stabilize. Record the pressure displayed on the monitor (P1).
8	Press and hold the "Alarm off" button on the monitor to release the pressure in steps of 3 mmHg (.4 kPa). Simultaneously, start the timer.
9	Stop the timer when the pressure drops below 150 mmHg (20 kPa). Calculate the deflation rate (X5): (starting pressure - 150)/# of seconds. The deflation rate should be 3.3 mmHg/s $\pm$ 1.5 mmHg/s (0.44 kPa/s $\pm$ 0.2 kPa/s).
10	Press and hold the <b>Volume</b> button until the monitor displays a pressure of 0 mmHg or kPa.
11	If no further NBP tests are to be conducted, turn the monitor Off. Normal monitoring operation returns the next time the monitor is turned On.

## Basic Pneumatic Leakage (BPL) Test

The purpose of this test is to verify the integrity of the NBP pneumatic system after the monitor has been opened. This includes all external and internal tubing connections.

No simulator is required for this test, and results are not required to be reported.

Step	Action
1	Attach the NBP cuff to the NBP tubing and the tubing to the NBP patient monitoring input connector.
2	Wrap the cuff around itself and place it on a table for the test. DO NOT place the cuff on your arm.
3	Turn the monitor On and enter the NBP test screen located within <b>Diagnostic Mode</b> .
4	Press the <b>Volume</b> button to close valves.
5	a. Press and hold the <b>NBP Start/Stop</b> switch until the monitor's screen reads "250 mmHg" or "33.3 kPa". b. Wait 15-20 seconds to allow the pressure to stabilize.
6	a. Note the value on the screen (P1), then start a timer. b. After one minute, note the value on the screen (P2). c. Calculate the difference between the two values (P1 - P2). The value should be less than or equal to 6 mmHg (0.8 kPa).
7	Press and hold the <b>Volume</b> button until the screen shows the pressure has released and the value is 0 mmHg or kPa.
8	Turn the monitor Off.

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### Note

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If the test fails, ensure the integrity of the cuff and tubing, then test again. If the test fails again, verify the integrity of all the pneumatic tubing inside the monitor.

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## Performance Procedures

The following accuracy and performance procedures are designed to be completed to verify the accuracy and performance of the monitor. They must be performed, according to the frequency specified in the section titled, “*Recommendations for Testing Frequency*” on page 4-6.

### Battery Performance Test

The battery performance test should be performed every two years, before monitor repairs, or whenever the battery is suspected as being a source of the problems. Before performing the battery performance test, verify that the battery is fully charged (see “*Charging the Battery*” on page 3-9).

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**Note**

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Before beginning this test, ensure that the monitor is disconnected from the AC power source.

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**Tools Needed:**

- SpO<sub>2</sub> adapter cable (M1943A)
- Clinical Dynamics Corp - SmartSat simulator (with Nellcor simulator cable)
- NBP tubing (M1599B)
- Bio-Tek BP Pump 2 simulator or equivalent, with an internal test volume of 310 ml

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**Note**

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The instructions below apply to the Bio-Tek BP Pump 2 simulator.

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Step	Action										
1	Connect SpO <sub>2</sub> simulator cable to the SpO <sub>2</sub> adapter cable. Connect the cable to the SpO <sub>2</sub> patient monitoring input connector.										
2	Connect the NBP simulator to the monitor via the NBP tubing.										
3	Set the SpO <sub>2</sub> simulator switches as follows: <table><tr><th>Item</th><th>Setting</th></tr><tr><td>Oximeter</td><td>Nellcor</td></tr><tr><td>SpO<sub>2</sub>%</td><td>81</td></tr><tr><td>BPM</td><td>36</td></tr><tr><td>Pulse Mod</td><td>0.50%</td></tr></table>	Item	Setting	Oximeter	Nellcor	SpO <sub>2</sub> %	81	BPM	36	Pulse Mod	0.50%
Item	Setting										
Oximeter	Nellcor										
SpO <sub>2</sub> %	81										
BPM	36										
Pulse Mod	0.50%										
4	Set the NBP simulator to a pressure setting of 120/80 mmHg (16/11 kPa), and a heart rate of 80 bpm.										



Step	Action
5	With the monitor Off, press the <b>On/Standby</b> button. (When the monitor is turned on, the battery icon may initially indicate a higher charge than it actually holds - wait 5 minutes or until after an NBP measurement for an accurate battery reading.)
6	Verify that the monitor is responding to the SpO <sub>2</sub> simulator signal and that the audible alarm is sounding. Use the navigation wheel to select the <b>SpO<sub>2</sub> Menu</b> and permanently silence the SpO <sub>2</sub> audible alarm. Select the <b>Heart Rate Menu</b> and silence the Heart Rate alarm.
7	Use the navigation wheel to select the <b>NBP Menu</b> and set the <b>Automatic Interval Mode</b> option to 15 minutes. Select <b>Return</b> to exit the menu.
8	Press the <b>NBP</b> button on the monitor's front panel to start the first NBP measurement. Subsequent NBP measurements are taken automatically every 15 minutes.
9	Verify that the battery icon displays at the bottom of the display. Note the time. (At least one segment of the battery icon should be filled.)
10	Keep the monitor On until the low battery warning alarm occurs. Note the time. Verify that alarm sounds 15-30 minutes before the battery fully discharges.
11	Keep the monitor On until it automatically powers down due to low battery condition. Verify that the audible alarm sounds when the monitor automatically shuts down. Note the time.  <b>Press any front panel button, on the monitor, to terminate this audible alarm.</b>
12	If the monitor passes this test, immediately recharge the battery. If it fails the test, replace the battery. (See <i>"Removing the Battery"</i> on page 7-4 for more information).

## Temperature Test

The accuracy of the monitor's temperature measurements is  $\pm 0.1^{\circ}\text{C}$  ( $\pm 0.2^{\circ}\text{F}$ ). In the procedure below, add the tolerance of the simulator to the acceptable range of readings.

### Tools Needed:

- Dynatech Nevada MedSim 300 or equivalent simulator
- Temperature cable (supplied with the temperature simulator)

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### Note

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The instructions below apply to the Dynatech Nevada MedSim 300.

---

Step	Action
1	Verify the monitor is turned Off. Connect the temperature cable to the appropriate connector on the temperature simulator.
2	Connect the temperature cable to the Temperature patient monitoring input connector.

Step	Action
3	Set the temperature simulator as follows: a. Temperature: 37°C (98.6°F). b. Probe Type: YSI 400 Series
4	Press the <b>On/Standby</b> button to turn the monitor On.
5	After the power-up sequence, verify the temperature reads 37°C ±0.1°C (98.6°F ±0.2°F if Fahrenheit is selected as the temperature unit).
6	Turn the monitor Off.

## ECG/ Respiration Performance

This section includes tests for both ECG and Respiration.

### Tools Needed for both ECG and Respiration testing:

- ECG leads - M1605A (AAMI) or M1615A (IEC)
- ECG trunk cables - M1540C (ICU, AAMI) or M1550C (ICU, IEC)
- Dynatech Nevada MedSim 300 or equivalent simulator

### ECG Test

The accuracy of the monitor's ECG measurements is  $\pm 5$  bpm. In the following procedure, add the tolerance of the simulator to the acceptable range of readings.

Step	Action
1	Verify that the monitor is turned Off. Connect the ECG leads to the appropriate jacks on the ECG simulator.
2	Connect the leads to the ECG trunk cable. Connect the cable to the ECG patient monitoring input connector.
3	Set the ECG simulator as follows: <div style="display: flex; justify-content: space-around; margin-top: 10px;"> <div style="text-align: center;"> <b>Set...</b> Heart Rate (HR) Lead select </div> <div style="text-align: center;"> <b>To...</b> 30 bpm II </div> </div>
4	Press the <b>On/Standby</b> button to turn the monitor On.
5	After the power-up sequence, verify the following monitor reactions: <ol style="list-style-type: none"> <li>a. After at least five heartbeats, the monitor displays a heart rate of <math>30 \pm 5</math> bpm.</li> <li>b. The audible alarm sounds and the Heart Rate frame flashes, indicating heart rate is below the default lower alarm limit.</li> </ol>
6	Press the <b>Alarm Silence</b> button twice (on the monitor's front panel) to invoke the Silence/Reset mode.
7	Increase the heart rate setting on the ECG simulator to 240 bpm. After at least five heartbeats, verify that the monitor displays a heart rate of $240 \pm 5$ bpm.
8	Verify that the audible alarm sounds and the Heart Rate frame flashes, indicating that the heart rate is above the default upper alarm limit.
9	Press the <b>Alarm Silence</b> button twice (on the monitor's front panel) to invoke the Silence/Reset mode.
10	Decrease the heart rate setting on the ECG simulator to 120 bpm. After at least five heartbeats, verify that the monitor displays a heart rate of $120 \pm 5$ bpm.
11	Disconnect the LL lead from the ECG simulator. Verify that the Leads Off alarm message displays. -?- displays in the Heart Rate frame, and the low priority "Leads Off" INOP sounds.
12	Reconnect the LL lead to the ECG simulator. Verify that the Leads Off alarm message no longer displays and the audible alarm is silenced.
13	Repeat steps 11 and 12 for LA and RA leads, then turn your monitor Off.

**Respiration Test**      The accuracy of the monitor's respiration measurements is  $\pm 3$  breaths per minute. In the procedure below, add the tolerance of the simulator to the acceptable range of readings.

Step	Action
1	Verify that the monitor is turned Off. Connect the ECG leads to the appropriate jacks on the ECG simulator.
2	Connect the ECG leads to the ECG trunk cable.
3	Connect the cable to the ECG patient monitoring input connector.
4	Set the simulator for a respiration rate of 120 breaths per minute.
5	Press the <b>On/Standby</b> button to turn the monitor On.
6	After the power-up sequence, verify the following monitor reactions: a. The monitor displays a respiration rate of $120 \pm 3$ breaths per minute. b. The audible alarm sounds and the Respiration Rate frame flashes, indicating the respiration rate is above the default upper alarm limit.
7	Press the <b>Alarm Silence</b> button to silence the alarm.
8	Decrease the respiration rate setting on the respiration simulator to 20 breaths per minute. Verify that the monitor displays a respiration rate of $20 \pm 3$ breaths per minute.

## SpO<sub>2</sub> Performance

SpO<sub>2</sub> testing includes the following tests:

- Dynamic Operating Range
- LED Excitation Test

### Tools Needed for SpO<sub>2</sub> Tests:

- Clinical Dynamics Corp - SmartSat simulator (with Nellcor simulator cable)
- SpO<sub>2</sub> adapter cable (M1943A)
- SpO<sub>2</sub> reusable sensor, adult finger (M1191A)

## Dynamic Operating Range Test

The following test sequence verifies proper monitor operation over a range of input signals.

Step	Action
1	Connect SpO <sub>2</sub> simulator cable to the SpO <sub>2</sub> adapter cable. Connect the cable to the SpO <sub>2</sub> patient monitoring input connector.
2	Set the simulator as indicated in the table below. Verify that the monitor readings are within the indicated tolerances. Allow the monitor several seconds to stabilize the readings.
3	Turn the monitor Off.

**Table 4-1. Settings and Monitor Indications**

Simulator Settings					Monitor Indications	
SpO <sub>2</sub> %	Pulse Rate	Ambient Light Freq	Ambient Light Ac Level	Modulation	SpO <sub>2</sub>	Pulse Rate
81	36	120	200	0.50%	79-83*	33-39*
81	112	120	200	5.00%	79-83*	109-115
81	201 <sup>a</sup>	120	10	0.50%	79-83*	195-207*
81	201 <sup>a</sup>	120	200	5.00%	79-83*	195-207*

An \* indicates values that produce an alarm. Press the **Alarm Silence** button to temporarily silence the audible alarm.

a. For the pulse rate setting of 201 bpm, the pulse rate tolerance of 195 to 207 bpm is greater than  $\pm 3$  bpm accuracy specification on the monitor, due to the performance characteristics of the simulator.

**LED Excitation  
Test**

This procedure uses normal system components to test circuit operation. A SpO<sub>2</sub>, adult finger, reusable sensor is used to examine LED intensity control. The red LED is used to verify intensity modulation caused by the LED intensity control circuit.

Step	Action
1	Connect an SpO <sub>2</sub> sensor to the monitor.
2	Press the <b>On/Standby</b> button to turn the monitor On.
3	After the monitor completes its normal power-up sequence, verify that the sensor LED is brightly lit.
4	Slowly move the sensor LED in proximity to the photo detector element of the sensor. Verify, as the LED approaches the optical sensor, that the LED intensity decreases.
5	Open the sensor and take note that the LED intensity increases.
6	Repeat Step 5 and the intensity again decreases. This variation is an indication that the micro-processor is in proper control of LED intensity.
7	Turn the monitor Off.

## CO<sub>2</sub> Performance

This test checks the performance of your CO<sub>2</sub> measurement for the monitor. This test uses calibration equipment that can be ordered (contact your Philips representative). Refer to the documentation accompanying the equipment for detailed instructions. The procedure is summarized in the following steps:

- Barometric Pressure Check and Calibration, if required
- Leakage Check
- Pump Check
- Flow Check and Calibration, if required
- CO<sub>2</sub> Cal Check and Calibration, if required
- CO<sub>2</sub> Cal Verification using Cal 2 gas

---

**Note**

---

Allow 5 seconds between individual service procedures in order to ensure stable equipment conditions.

---

**Tools Needed for CO<sub>2</sub> Tests:**

- Screwdriver
- Tweezers
- Cal 1 gas (5% CO<sub>2</sub>)
- Cal 2 gas (10% CO<sub>2</sub>)
- Cal gas flow regulator
- Cal tube

You also need a local barometric pressure rating received from a reliable local source, such as an airport, regional weather station, or hospital weather station. The pressure rating must be located at the same altitude as the hospital.

---

**Note**

---

All steps must be performed in the same session.

---

## Documenting CO<sub>2</sub> Test Results

The following table lists the CO<sub>2</sub> tests and summarizes how to document the test results.

Test	Expected Test Results	What to record on service record
Barometric Pressure Check	X1 = difference between the reference pressure and the measured ambient pressure displayed on the monitor (-12 mmHg < X1 < +12 mmHg)	PCO <sub>2</sub> : P/X1/X2/X3/X4/X5/X6/X7 or PCO <sub>2</sub> : F/X1/X2/X3/X4/X5/X6/X7  P = passed, F = failed  X1: xx (two digits)  X2: x.x X3: x.x X4: xxx X5: x.x X6: x.x X7: x.x
Leakage Check parts 1 and 2	X2 = value of part 1 leakage check on flowmeter (X2 <= 4.0 ml/min) X3 = value of part 2 leakage check on flowmeter (X3 <= 4.0 ml/min)	
Pump Check	X4 > 120 mmHg below the ambient pressure	
Flow Rate Check	X5 = CO <sub>2</sub> flow rate (42.5 ml/min < X5 < 65 ml/min).	
CO <sub>2</sub> Gas Measurement Calibration Check	X6 = difference between measured CO <sub>2</sub> value and calculated value, based on 5% CO <sub>2</sub> cal. gas (X7 < 2.6 mmHg, or 0.35 kPa)	
Calibration Verification	X7 = difference between measured CO <sub>2</sub> value and calculated value, based on 10% CO <sub>2</sub> cal. gas. (X7 ± {0.07 x value calculated})	



# **Barometric Pressure Check and Calibration**

Check the barometric pressure value in the CO<sub>2</sub> module as follows:

Step	Action
1	Enter the <b>Power-Up Defaults Menu</b> (see “ <i>Power-Up Defaults Menu</i> ” on page 5-3” for instructions on accessing this menu).
2	Select the <b>Enter Diagnostic Mode?</b> option.
3	From the popup menu, select <b>Yes</b> . The <b>Diagnostic Menu</b> displays.
4	Select the <b>CO<sub>2</sub> Test</b> option.
5	Connect a FilterLine to the CO <sub>2</sub> patient monitoring input connector. This activates the pump in the CO <sub>2</sub> module.
6	Check the status line at the top of the screen. It will display "CO <sub>2</sub> pressure in mmHg (ambient/cell) xxx/yyy" where xxx is the ambient pressure and yyy is the measured cell pressure. The values are displayed with a resolution of 2 mmHg (0.3 kPa) up to 475 mmHg (63.2 kPa) and a resolution of 1 mmHg (0.1 kPa) from 475 mmHg (63.2 kPa) to 825 mmHg (109.7 kPa). Check whether the ambient pressure (X1) matches (within the acceptable tolerance of $\pm 12$ mmHg) the reference value you have received. If so, proceed to the “ <i>Leakage Check</i> ”. If the value is not correct, calibrate as follows.
7	Select <b>Set Barometric Pressure (mmHg)</b> . An adjustable value in mmHg is activated.
8	Select the value that matches the reference value received from a reliable local source, such as an airport, regional weather station or hospital weather station.
9	If the selected value is not within $\pm 12$ mmHg (1.6 kPa) of the current measured ambient pressure, verify the reference value by getting another reading from a different source. If the ambient pressure displayed also differs from the new reference by more than $\pm 12$ mmHg (1.6 kPa), the CO <sub>2</sub> module should be replaced.
10	Confirm the barometric pressure setting by clicking on the adjusted value so that it is no longer highlighted.
11	Check that the ambient pressure displayed in the CO <sub>2</sub> Pressure line at the top of the screen is the same as the value that you selected from the list in Step 8.

**Leakage Check**

The Leakage Check consists of two parts:

- Part 1 - Checking the tubing between the pump outlet and the CO<sub>2</sub> module outlet.
- Part 2 - Checking the tubing between the pump inlet and the FilterLine inlet.

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**Note**


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Check the flowmeter's user guide for details on how to make a correct flow reading.

---

**Part 1**

Step	Action
1	Check the ambient and cell pressure shown in the status line on the screen. The cell pressure should be approximately 20 mmHg (2.7 kPa) lower than the ambient pressure.
2	Connect the flowmeter outlet to the FilterLine inlet using a flexible connecting tube.
3	Block the CO <sub>2</sub> module outlet using your fingertip and observe the flowmeter display. The value on the flowmeter (X2) should decrease to between 0 and 4 ml/minute. If the value is not within the tolerance limits, there is a leakage between the pump outlet and the CO <sub>2</sub> module gas outlet.
4	If a leakage is found in Step 3, open the CO <sub>2</sub> module and check the tubing connections at the pump outlet and the module CO <sub>2</sub> gas outlet. If the connections are good, then there is leakage in the module and the CO <sub>2</sub> module must be exchanged.

**Part 2**

Step	Action
1	Disconnect the flowmeter from the Part 1 setup and connect the flowmeter inlet to the CO <sub>2</sub> module gas outlet.
2	Leave the FilterLine connected to the CO <sub>2</sub> module inlet.
3	Block the inlet of the FilterLine using your fingertip and observe the flowmeter display. The value on the flowmeter (X3) should decrease to between 0 and 4 ml/minute. If the value is within the tolerance limits, there are no leakages and the leakage check is completed. You can proceed to the " <i>Pump Check</i> ".
4	If the value is not within the tolerance limits, there is a leakage between the FilterLine inlet and the pump inlet.
5	Check the FilterLine connections and open the monitor to check the tubing connections at the pump inlet and the CO <sub>2</sub> module gas inlet. If the connections are good, try replacing the FilterLine and repeating the leakage check. If the situation remains, there is a leakage in the tubing and the CO <sub>2</sub> module must be exchanged.

## Pump Check

Step	Action
1	Connect the flowmeter inlet to the CO <sub>2</sub> module gas outlet.
2	Connect the FilterLine to the CO <sub>2</sub> module inlet.
3	Block the inlet of the FilterLine using your fingertip and observe the cell pressure to the right of the slash symbol on the top row of the CO <sub>2</sub> Test display screen.  The cell pressure (X4) should be more than 120 mmHg below the ambient pressure shown. If the pressure difference is less than 120 mmHg, the pump is not strong enough and should be replaced (regardless of the Pump Op Time).

## Flow Rate Check and Calibration

Step	Action
1	Connect the flowmeter to the CO <sub>2</sub> FilterLine.
2	On the flowmeter, check the flow that the CO <sub>2</sub> Pump draws (X5). The nominal value is 50; the acceptable limits are 42.5 and 65 ml/minute. If the value is within these limits, proceed to the CO <sub>2</sub> Gas calibration check. If not within the limits, calibrate as follows.
3	Select <b>Flow Rate Check and Calibration</b> . Adjust the flow in the monitor by selecting <b>Increase Flow</b> or <b>Decrease Flow</b> until it is as close as possible to 50 ml per minute as indicated on the flowmeter gauge. The pump voltage displayed on the second row of the CO <sub>2</sub> Test screen will vary as the flow is changed.
4	When you are satisfied that the flow is set as close as possible to 50 ml per minute, select <b>Store Flow</b> to confirm the setting

---

### Note

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If the adjusted flow is not stored within 60 seconds of the adjustment, the old flow setting is restored. If the flow cannot be adjusted to within tolerance, the pump should be replaced. If the flow adjustment still cannot be made, this indicates a fault in the CO<sub>2</sub> module, which must be replaced.

---

### CO<sub>2</sub> Gas Measurement Calibration Check

After switching the monitor on, or after turning on the etCO<sub>2</sub> On/Off setting in the etCO<sub>2</sub> frame, wait at least 20 minutes before checking the calibration.

Step	Action
1	Check that the 5% calibration gas and flow regulator are connected.
2	<p>Calculate the expected measurement value in mmHg as follows:</p> $0.05 \times (\text{ambient pressure}) / 1.03 = \text{value mmHg}$ <p>i.e. <math>0.05 \times 736 \text{ mmHg} / 1.03 = 35.7 \text{ mmHg}</math> (with an ambient pressure of 736 mmHg)</p> <p><i>Note: Dividing by 1.03 compensates for the dry calibration gas at room temperature, relative to breath gases containing water vapor and at body temperature.</i></p>
3	Select <b>CO<sub>2</sub> Calibration</b> . Wait for the status message "CO <sub>2</sub> module reset in progress" to disappear. Open the valve on the flow regulator to allow 5% CO <sub>2</sub> gas to flow into the monitor. Allow the displayed CO <sub>2</sub> value (third row of <b>CO<sub>2</sub> Test</b> menu) to stabilize.
4	Check that the CO <sub>2</sub> value on the monitor matches the calculated mmHg value $\pm 2.6 \text{ mmHg}$ . If the value is outside the tolerance, calibrate as described in Step 9 to 13.
5	Disconnect the 5% calibration gas and connect the 10% calibration gas.
6	<p>Calculate the expected measurement value and tolerance in mmHg as follows:</p> $0.1 \times (\text{ambient pressure}) / 1.03 = \text{value mmHg}$ $\pm 0.07 \times (\text{value mmHg}) = \text{tolerance}$ <p>i.e. <math>0.1 \times 737 \text{ mmHg} / 1.03 = 71.6 \text{ mmHg}</math> (with an ambient pressure of 737 mmHg)</p> $\pm 0.07 \times 71.6 \text{ mmHg} = \pm 5.01 \text{ mmHg tolerance}$
7	Open the valve on the flow regulator to allow 10% CO <sub>2</sub> gas to flow into the monitor. Allow the value to stabilize.
8	Check that the value on the monitor (X6) matches the calculated mmHg value within the calculated tolerance. If so, the CO <sub>2</sub> module is correctly calibrated. If the value is outside the tolerance, calibrate as follows.
9	If not already connected, connect the 5% calibration gas.
10	Select <b>CO<sub>2</sub> Calibration</b> to enter the Calibration sub-menu. Wait for the status message "CO <sub>2</sub> module reset in progress" to disappear.
11	Select the value for the calibration gas (The default value is 5%).
12	Select <b>Start Calibration</b> and open the valve on the calibration gas to allow CO <sub>2</sub> gas to flow into the monitor. Allow the value to stabilize before the start of the calibration. Leave the valve open until the monitor gives a prompt that the gas can be removed.
13	The CO <sub>2</sub> module calibrates and prompts when calibration is successful.

### Calibration Verification

Step	Action
1	Reopen the 5% gas valve and allow the value to stabilize.
2	Check that the value displayed on the monitor is correct and within the tolerance (see Step 2 in above section).
3	Disconnect the 5% calibration gas and connect the 10% calibration gas.
4	Open the valve on the flow regulator to allow 10% CO <sub>2</sub> gas to flow into the monitor. Allow the value to stabilize.
5	Check that the value displayed on the monitor (X7) is correct and within the tolerance (see Step 6 above). If one or both values are not within tolerances, the CO <sub>2</sub> module must be exchanged.

### Reset Pump Operating Time Counters

If the pump in the CO<sub>2</sub> module is replaced, the Pump Operating Time counter should be reset to start counting operating time for the new pump.

Step	Action
1	In the CO <sub>2</sub> Test menu, select Pump Op Time.
2	Select <b>Reset to Zero</b> .

---

#### Note

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When the Pump Op Time has been reset a "CO<sub>2</sub> Equipment Malfunction" INOP will be generated on restarting the monitor. To clear this INOP you must perform a flow check and store the flow in **Diagnostic Mode** (select **Store Flow**).

---

## Serial Interface and Nurse Call Signal Test

Perform the following procedure to test the serial port voltages. The test is qualitative and only verifies that the serial interface port is powered correctly, and that the Nurse Call signal is operational. The serial connector is a male DB-9 located on the monitor's rear panel, identified by the RS-232 symbol.

### Tools Needed:

- Clinical Dynamics Corp - SmartSat simulator (with Nellcor simulator cable)
- SpO<sub>2</sub> adapter cable (M1943A)

Step	Action										
1	Turn the monitor On.										
2	Set up the DMM with the function set to VDC at a range of 10 volts.										
3	Connect the DMM negative lead to connector pin 5 (GND), or the shell of the RS-232 connector.										
4	Referring to <i>Table 4-2, Serial Interface Voltages</i> , connect the DMM positive lead to each pin in turn, and verify the voltage values listed. Voltage for pin 9 is that listed from the No Alarm condition.										
5	Connect SpO <sub>2</sub> simulator cable to the SpO <sub>2</sub> adapter cable. Connect the cable to the SpO <sub>2</sub> patient monitoring input connector.										
6	Set the simulator switches as follows: <table> <tr> <th>Item</th><th>Setting</th></tr> <tr> <td>Oximeter</td><td>Nellcor</td></tr> <tr> <td>SpO<sub>2</sub>%</td><td>81</td></tr> <tr> <td>BPM</td><td>36</td></tr> <tr> <td>Pulse Mod</td><td>0.50%</td></tr> </table>	Item	Setting	Oximeter	Nellcor	SpO <sub>2</sub> %	81	BPM	36	Pulse Mod	0.50%
Item	Setting										
Oximeter	Nellcor										
SpO <sub>2</sub> %	81										
BPM	36										
Pulse Mod	0.50%										
7	Verify that the monitor is responding to the SpO <sub>2</sub> simulator signal and the audible alarm is sounding. If desired, press the <b>Alarm Silence</b> button to temporarily silence the audible alarm.										
8	Connect the DMM positive lead to pin 9 and verify the voltage value listed in <i>Table 4-2, Serial Interface Voltages</i> . The voltage for pin 9 is that listed for the Alarm Underway condition.										

**Table 4-2. Serial Interface Voltages**

Pin	Signal	Direction	Measurement (V)		
			Min.	Typical	Max.
1	not used		-0.4	0.0	0.4
2	RXD <<<<	input	-0.4	0.0	0.4
3	TXD <<<<	output	-5.0	-7.0	-15.0
4	DTR <<<<	output	5.0	7.0	15.0
5	GND		-0.4	0.0	0.4
6	DSR <<<<	input	-0.4	0.0	4.0
7	RTS >>>>	output	5.0	7.0	15.0

Pin	Signal	Direction	Measurement (V)		
8	CTS<<<	input	-0.4	0.0	0.4
9	Alarm Out>>> (no alarm)	output	-5.0	-7.0	-15.0
9	Alarm Out>>> (alarm underway)	output	5.0	7.0	15.0

## ECG Sync Test

This test checks the performance of ECG synchronization between the monitor and a defibrillator. The ECG sync performance test is required once every year and when the monitor is repaired or when the monitor's parts are replaced.

**Tools Needed:**

- Dynatech Nevada MedSim 300 or equivalent simulator
- Defib Sync Cable (M4820A) or Switchcraft 850
- Switchcraft 750

Two sections are needed to complete the connection from the monitor to the simulator.

1. If a Defib Sync Cable is available, connect it the ECG Sync output on the monitor, then to the Switchcraft 750.  
or  
If a Switchcraft 850 is available, connect it the ECG Sync output on the monitor, then to the Switchcraft 750.
2. Connect the Switchcraft 750 to the SYNC/A PACE input on the simulator

Connect to the monitor	Connect to the simulator
Defib Sync Cable	Switchcraft 750
Switchcraft 850	Switchcraft 750

Step	Action
1	Connect the ECG leads and trunk cables between the monitor and the simulator (as described above).
2	Turn on the monitor and the simulator
3	On the simulator main menu select <b>DEFB</b> , then <b>CARD</b> to set the simulator to Defibrillator Tests/Cardioversion.
4	Press <b>Start</b> to begin the test. If the monitor is working properly, the following sequence of text messages will appear on the simulator over a period of approximately 3 seconds: "cardioversion: afib", "cardioversion: sync ok", and "cardioversion: converted" (this message will persist on the simulator)
5	If the monitor isn't working properly, messages such as the following may appear: "cardioversion: vfib", "cardioversion: late".



## Patient Safety Tests

Philips safety tests meet the standards of, and are performed in accordance with IEC 60601-1, Clause 19 (EN60601-1, Second Edition, 1988; Amendment 1, 1991-11, Amendment 2, 1995-03).

The C3 patient monitor is a Class I device. It requires a protective earth (ground) wire. Keep this in mind when performing the following test procedures.

There are two categories of safety tests:

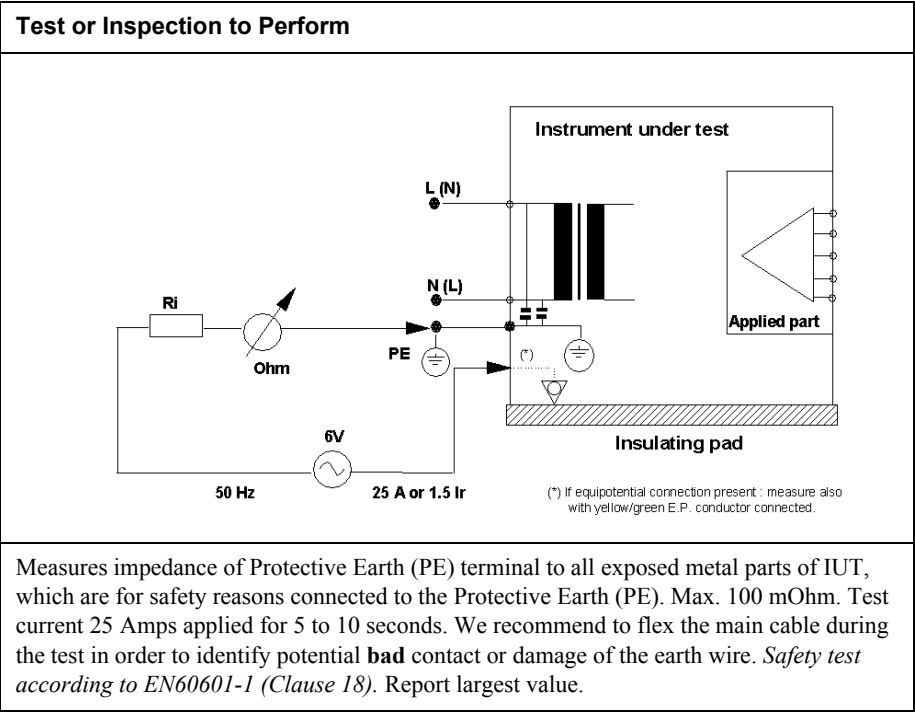
- Ground Integrity
- Electrical Leakage

### Ground Integrity

Table 4-3. Ground Integrity

Test or "Inspection" to Perform	Expected Test Results
Protective Earth  See "Safety Test Diagram - Protective Earth" on page 4-40.	With mains cable:  Maximum impedance = $x \leq 100 \text{ mOhms}$

Figure 4-1 Safety Test Diagram - Protective Earth



What to record on this service record:

S(1): P or S(1): F

## Electrical Leakage

The following tests verify the electrical leakage of the monitor:

- Earth Leakage Current
- Enclosure Leakage Current
- Patient Leakage Current
- Patient Source Current, with Mains Voltage on the Applied Part

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### **Warning**

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**Perform all leakage tests any time the unit is opened.**

---

## Earth Leakage Current

This test is in compliance with IEC 60601-1 (Earth Leakage Current). In locations where mains voltage is 100-120 volts, the applied voltage is 132 volts. In locations where mains voltage is 220-240 volts, the applied voltage is 264 volts. The applied AC frequency should be the same as the local mains (50 or 60 Hz).

All measurements shall be made with the power switch in both On and Off positions.

1. Connect the monitor AC plug to the electrical safety analyzer as recommended by the analyzer operating instructions.
2. Perform test as recommended by analyzer operating instructions.

Earth leakage current is measured under various conditions of the AC mains and protective earth conductor. For each condition, the measured leakage current must not exceed that indicated below.

**Table 4-4. Earth Leakage Current Values**

Test Condition	Polarity	Allowable Leakage Current
Normal	Normal	300 $\mu$ A
	Reversed	300 $\mu$ A
S.F.C <sup>a</sup>	Normal	1000 $\mu$ A
Open Supply	Reversed	1000 $\mu$ A

a. S.F.C = Single Fault Condition

What to record on the service record:

S(2): P or S(2): F

### Enclosure Leakage Current

This test is compliance with EN60601-1 (Enclosure Leakage Current). Test at 110% of the nominal line voltage.

Step	Action
1	Connect the AC mains power cord to the analyzer as recommended by the analyzer operating instructions.
2	Using the appropriate test cable, connect the analyzer to either of the screws on the back of the monitor, next to the handle.
3	Turn the monitor on.
4	Perform the test as recommended by the analyzer operating instructions.

The analyzer leakage current indication must not exceed the values listed below.

**Table 4-5. Enclosure Leakage Current**

EN60601-1 (1990 + A1, A2, A11, A12, A13) and UL2601 (2<sup>nd</sup> Ed. 1997) US Deviations

Test Condition	Polarity	Allowable Leakage Current
Normal	Normal	100 $\mu$ A
	Reversed	100 $\mu$ A
S.F.C <sup>1</sup> Open Protective Earth	Normal	300 $\mu$ A
	Reversed	300 $\mu$ A

What to record on your service record:

S(3): P or S(3): F

**Patient  
Leakage  
Current**

This test measures patient leakage current in accordance with EN60601-1, Clause 19, for Class I, type CF equipment. Patient leakage current in this test is measured from any individual patient connection to earth (power ground).

This test requires a sample patient cable for each device parameter. These must be configured as recommended by the safety analyzer operating instructions.

Step	Action
1	Configure the electrical safety analyzer as recommended by the analyzer operating instructions.
2	Connect the monitor's AC mains power cord to the analyzer as recommended by analyzer operating instructions.
3	Connect the ECG test cable between the ECG connector on the monitor and the appropriate input connector on the analyzer.
4	Turn the monitor On.
5	Perform the test as recommended by the analyzer operating instructions.  Patient leakage current is measured under various conditions of the AC mains and protective earth conductor. For each condition, the measured leakage current must not exceed that indicated below.
6	Repeat the test for SpO <sub>2</sub> and temperature patient connections, using appropriate test cables.

**Table 4-6. Patient Leakage Current Values**

Test Condition	Polarity	Allowable Leakage Current (Max.)
		Type CF
Normal	Normal	10 $\mu$ A
	Reversed	10 $\mu$ A
S.F.C.(Open Earth/Ground)	Normal	50 $\mu$ A
	Reversed	50 $\mu$ A

What to record on the service record:

S(4): P or S(4): F

**Patient  
Leakage  
Current, with  
Mains Voltage  
on the Applied  
Part**

This test measures patient leakage current in accordance with EN60601-1, Clause 19, for Class I, type CF equipment. In this test, 110% of mains voltage is applied between each patient connection and earth (power ground). Patient leakage current is then measured from any individual patient connection to earth.

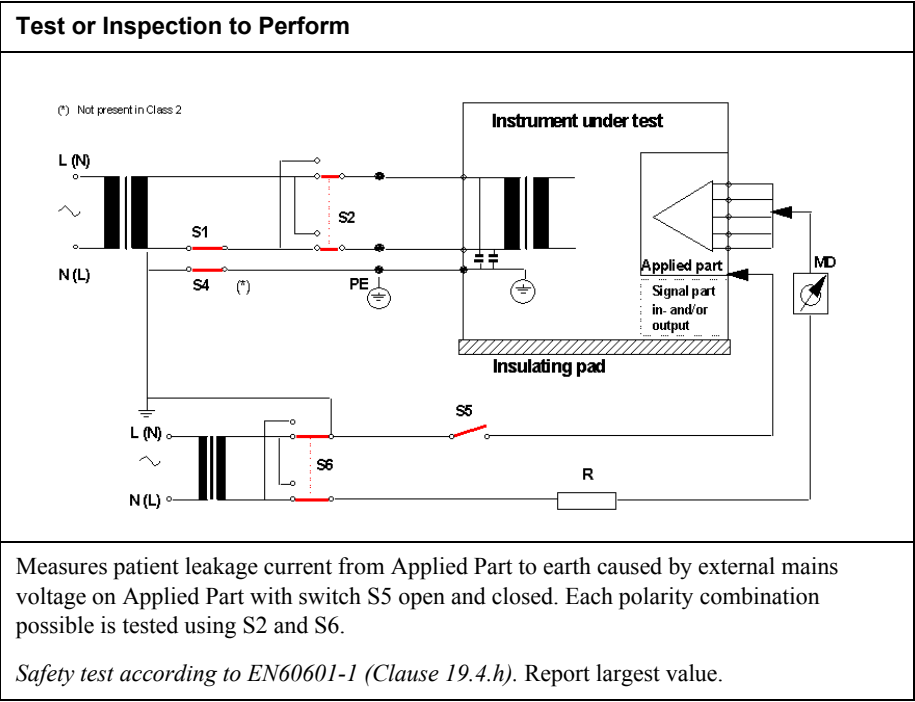
**Warning**

AC mains voltage is present on the applied part terminals during this test. Exercise caution to avoid electrical shock hazard.

**Table 4-7. Safety Tests - Patient Leakage Current, with Mains Voltage on the Applied Part**

Test or “Inspection” to Perform	Expected Test Results
Patient Leakage Current - AC  See “Safety Test Diagram - Patient Leakage Current - AC” on page 4-44	Maximum leakage current = x  <= 50 µA @ 250V (IEC601-1 or UL2601-1)  Test at 110% of the nominal line voltage.

**Figure 4-2 Safety Test Diagram - Patient Leakage Current - AC**



What to record on the service record:

S(5): P or S(5): F







# Configuring the Power-up Defaults Menu

This chapter discusses the use of the **Power-up Defaults Menu** to configure power-on default settings. It also explains how to use Diagnostic Mode to obtain service-related information about the monitor.

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## General Safety Information

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### **Warning**

**A blood pressure cuff, connected to the monitor, should never be applied to a human being while the monitor is in Diagnostic Mode. Injury could result.**

**A FilterLine, connected to the monitor, should never be applied to a human being while the monitor is in Diagnostic Mode. Injury could result.**

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### **Caution**

In addition to restoring factory defaults, this procedure clears the contents of trend memory.

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### **Note**

Before performing the first step, read this procedure COMPLETELY.

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## Power-Up Defaults Menu

The purpose of the **Power-up Defaults Menu** is to allow the authorized user to create a power-up default for each setting in the monitor. Power-up defaults are the settings in effect each time the monitor is power on. After you enter the Power-up Defaults Menu, physiological monitoring is terminated. The screen layouts do not display any information associated with normal monitoring operation.

After configuring the main monitoring screen and connecting the appropriate accessories, as not in the **C3 Information for Use** guide, use the following procedure to configure the power-up default settings for the monitor:

Step	Action																				
1	From the main monitoring screen, use the navigation wheel to highlight the <b>Setup</b> icon. Press the wheel to select the icon.																				
2	From the <b>Set-Up Menu</b> , select <b>Enter Power -up Default Menu</b> . A popup box displays.																				
3	Use the wheel to enter the passcode. The passcode is: <b>2 1 5</b> . <b>Note:</b> This passcode is configured at the factory and CANNOT be changed.																				
4	<p>The <b>Power-Up Defaults Menu</b> displays.</p> <div data-bbox="670 1102 1239 1528" data-label="Table"> <table> <tr> <th colspan="2"><b>POWER-UP DEFAULT MENU</b></th></tr> <tr> <td colspan="2">Accept Current Settings?</td></tr> <tr> <td colspan="2">Selected Audio Off (Make Available)</td></tr> <tr> <td colspan="2">Audio Off (Make Available)</td></tr> <tr> <td colspan="2">Auto-Set Limits (Make Available)</td></tr> <tr> <td colspan="2">Audio Pause Period (180s)</td></tr> <tr> <td colspan="2">Enter Diagnostic Mode?</td></tr> <tr> <td colspan="2">Language</td></tr> <tr> <td colspan="2">Enter Demo Mode?</td></tr> <tr> <td colspan="2">Return</td></tr> </table> </div> <p>The available menu items are described in the next section. You can configure these menu items as desired.</p>	<b>POWER-UP DEFAULT MENU</b>		Accept Current Settings?		Selected Audio Off (Make Available)		Audio Off (Make Available)		Auto-Set Limits (Make Available)		Audio Pause Period (180s)		Enter Diagnostic Mode?		Language		Enter Demo Mode?		Return	
<b>POWER-UP DEFAULT MENU</b>																					
Accept Current Settings?																					
Selected Audio Off (Make Available)																					
Audio Off (Make Available)																					
Auto-Set Limits (Make Available)																					
Audio Pause Period (180s)																					
Enter Diagnostic Mode?																					
Language																					
Enter Demo Mode?																					
Return																					
5	After making the desired change, highlight <b>Access Current Settings?</b> Press the wheel to select this option.																				
6	From the popup menu, select <b>Yes</b> .																				
7	<p>Select <b>Return</b>.</p> <p>After selecting <b>Return</b>, a notice displays instructing you to power down the monitor. Next time you power on, the changes you made to the defaults are implemented.</p>																				

## Menu Options

Below are the menu options you can configure from the **Power-up Defaults Menu**.

Menu Item	Choices	Explanation
Accept Current Settings	Yes No	If <b>Yes</b> is chosen, the current monitor settings become the power-up defaults.
Selected Audio Off	Make Available (default) Deny Access	If <b>Make Available</b> is chosen, audible alarms are permanently silenced for a particular parameter via the <b>Alarm Limits Menu</b> .  Some institutions may want to prevent audible alarms from being permanently silenced. If so, select <b>Deny Access</b> .
Audio Off	Make Available (default) Deny Access	If <b>Make Available</b> is chosen, Alarm Suspend Mode can be invoked by pressing and holding the <b>Alarm Silence</b> button for 2 seconds.  Some institutions may wish to prevent Alarm Suspend from being invoked. If so, select <b>Deny Access</b> .
Auto-Set Limits	Make Available (default) Deny Access	If <b>Make Available</b> is chosen, Auto-Set Limits are invoked via the <b>Alarm/Limits Menu</b> .  Some institutions may wish to prevent Auto-Set Limits from being invoked. If so, select <b>Deny Access</b> .
Silence Period	30, 60, 90, 120, 180 s (default)	Time is indicated in seconds. Pressing the front panel <b>Alarm Silence</b> button temporarily silences audible alarms for the time indicated
Enter Diagnostic Mode	Yes No	If <b>Yes</b> is chosen, the <b>Power-Up Defaults Menu</b> is exited and the <b>Diagnostic Menu</b> displays. For more information see <i>"Diagnostic Mode"</i> on page 5-5.
Language <sup>a</sup>	English, French, German, Italian, Japanese, Portuguese, Spanish, Russian, Chinese, Dutch, Turkish, Arabic, Norwegian, Swedish, Finnish, Polish, Czech	All text shown on the screen is in the selected language. The selected language is effective the next time the monitor is powered up.
Return		When selected, the <b>Power-Up Defaults Menu</b> is immediately exited and you are instructed to power down the monitor.

a. Although the language choices are shown here in English, they display on the screen in their respective language and script on the Boot Up screen and in the **Power-Up Defaults Menu**.

---

## Diagnostic Mode

The purpose of the **Diagnostic Mode Menu** option is to allow factory, field-service, and hospital biomedical technicians access to a series of test and system-related information screens for the purpose of verifying monitor performance, or troubleshooting problems.

To access Diagnostic Mode:

Step	Action
1	Enter the <b>Power-Up Defaults Menu</b> (see “ <i>Power-Up Defaults Menu</i> ” on page 5-3” for instructions on accessing this menu).
2	Select the <b>Enter Diagnostic Mode?</b> option.
3	From the popup menu, select <b>Yes</b> . The <b>Diagnostic Menu</b> displays.

DIAGNOSTIC MENU
Error Codes System Information System A/D Values NBP Test CO2 Test  Return

The **Diagnostic Menu** lists the test and system-related information screens. Select an item in the menu to invoke a test or information screen. The test and information screens that are in the diagnostic menu listed below. An explanation of each menu item is given in the sections that follow.

- Error Codes
- System Information
- System A/D Values
- NBP Test
- CO<sub>2</sub> Test

Error Codes

DIAGNOSTIC MENU	
ERROR CODES	
Error Codes	Date/Time
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	
10.	
Return	

This screen displays the 10 most recent error code types, logged by the monitor. The date and time that the error code appears displays to the right of the error code.

Error codes cannot be changed or reset in this screen. When in the Error Code screen, the **Return** option is always highlighted. Press the wheel to return to the main monitoring screen. Rotating the navigation wheel while in the Error Code screen has no effect.

Refer to “*Error Code Categories*” on 6-12, for more details on error codes.

System Information

DIAGNOSTIC MENU	
SYSTEM INFORMATION	
Monitor On-Time	0
Backlight On-Time	0
Recorder On-Time	0
Battery Deep Discharges	0
System Software Version	Application V1.00
CO2 Software Version	00.01 NL V01.11 09/05/2000 SN 10971
SpO2 Software Version	SW 3.11 ALG 2.57 HW 0.0 DSPFW 0.16
NBP Software Version	AG 2.27 SM V219 a
	123456 Cycle 369
Return	

When in the System Information screen, the wheel can be rotated to select any of the changeable items. If one of those items is selected, a press of the wheel displays a popup menu. The first item is **Make No Change**; the second item is **Reset to Zero**.

This screen displays several system-related items. They are as follows:

Menu Item	Function
Monitor On-Time	Displays the number of hours, rounded to the nearest hour, that the Main PCB has been operational. This value CANNOT be reset.
Backlight On-Time	Displays the number of hours, rounded to the nearest hour, that the LCD Backlight has been operational. This value can be reset to zero. An example is when a technician changes the backlight or installs a new LCD.
Recorder On-Time	Displays the number of hours, rounded to the nearest hour, that the C3 recorder has been operational. This value can be reset to zero. An example is when a technician installs a new recorder.
Battery Deep Discharges	Displays the number of deep-discharge cycles seen by the battery. The monitor records a deep discharge cycle when the battery volt-age reaches 5.6 volts. At this voltage, a <b>Low Battery</b> alarm is issued. This value can be reset to zero. An example is when a technician installs a new battery.
System Software Version	Displays the revision level of the system software. The revision level is also momentarily shown on the LCD as part of the Copyright screen. The value CANNOT be changed.
CO <sub>2</sub> Software Version	Displays the revision level of the software of the Oridion <sup>®</sup> CO <sub>2</sub> module. This value CANNOT be changed.
SpO <sub>2</sub> Software Version	Displays the revision level of the software of the MP-205 SpO <sub>2</sub> module. This value CANNOT be changed.
NBP Software Version	Displays the revision level of the software for the NBP module. This value CANNOT be changed.
Return	Exits the <b>System Information Menu</b> and returns to the <b>Diagnostic Menu</b> .

**System A/D Values**

The System A/D screen displays the current value of each analog-to-digital (A/D) channel in volts. Some of the channels are for AC-coupled signals (such as ECG input), so the numbers on the screen are constantly changing when an input signal is present. These AC-coupled values are shown to give an indication as to whether basic functionality of the channel is present, but no significance can be derived from the values of the numbers displayed.

DIAGNOSTIC MENU			
SYSTEM A/D VALUES			
1.		12.	
2.		13.	
3.		14.	
4.		15.	
5.		16.	
6.		17.	
7.		18.	
8.		19.	
9.		20.	
10.		21.	
11.			
SpO2 S1	SpO2 Alive	SpO2 S2	No Sensor
Return			

The Primary and Secondary Status messages from the SpO<sub>2</sub> module are displayed and updated at the rate of about once per second. Presence of the correct SpO<sub>2</sub> message indicates that, at a basic level, communication between the SpO<sub>2</sub> module and the main monitor processor is working correctly. None of the displayed values can be changed or reset in this screen. When in the System A/D screen, the **Return** option is always highlighted. Press the wheel to return to the **Diagnostic Menu**. Rotating the wheel while in the System A/D screen has no effect. The A/D channel designators are shown in the following table.



**Table 5-1. A/D Channel Designators**

1.	ECG
2.	RWAVE
3.	PACEMAKER
4.	RESPIRATION
5.	PRESSURE XDUCER 1
6.	PRESSURE XDUCER 2
7.	NBP OSCILLATORY
8.	ECG LEAD OFF
9.	TEMPERATURE
10.	ISOLATED VOLTAGE REF
11.	ISOLATED VOLTAGE ZERO
12.	SpO <sub>2</sub> S1 S018
13.	NOT USED
14.	+3.3 VDC POWER SUPPLY
15.	(+12 VDC POWER SUPPLY) x 0.33
16.	(NBP VOLTAGE REF) x 0.8
17.	GROUND REFERENCE
18.	(+5 VDC POWER SUPPLY) x 0.8
19.	ADC MID-SCALE VALUE
20.	ADC ZERO-SCALE VALUE
21.	ADC FULL-SCALE VALUE

**NBP Test**

A NBP Test screen is provided to facilitate troubleshooting problems and performing verification testing for the NBP subsystem. Typically, when these tests are performed, the pneumatic system is connected to an external pressure-reading device and a closed reference volume. The NBP Test screen provides a real-time numeric display of the pressure in the pneumatic system, means for controlling the pump and valves are open or closed.

**Warning**

**A blood pressure cuff, connected to the monitor, should never be applied to a human being while the monitor is in Diagnostic Mode. Injury could result.**

DIAGNOSTIC MENU	
NBP TEST	
Pressure (mmHg) 0	Proportional Valve: Open
	Proportional Valve: Open
Press NBP to activate pump; release to stop pump.	
Press Volume to open both valves; release to close valve.	
Press Alarm Silence to open proportional valve and deflate at 3mmHg/s; release to close valve	
Press Contrast to perform offset adjustment	
Return	

The NBP Test screen elements are described below:

Menu Item	Function
Pressure (mmHg)	Displays the real-time value of the system pneumatic pressure in mmHg. The value is updated at the rate of approximately two times per second.
Proportional Valve	Indicates whether the proportional value is open or closed.
Safety Valve	Indicates whether the safety valve is open or closed.

Menu Item	Function
Activate Pump	As long as the <b>NBP</b> button is pressed, the pump runs. If system pressure reaches the hardware over-pressure protection point (280 to 330 mmHg or 37.3 to 44.0 kPa), the safety valve opens and the pump disables, until the pressure falls below the safety threshold.
Open Both Valves	As long as the <b>Volume</b> button is pressed, the safety valve and proportional valve opens and remains at maximum.
Deflate	As long as the <b>Alarm Silence</b> button is pressed, the proportional valve opens and bleeds off pressure at the rate of $3 \pm 1.5$ mmHg/s. It is useful to control the bleed rate to 3mmHg/s to facilitate certain AAMI SP10 tests. Any time the bleed rate falls below 3 mmHg/s, the valve opens and remains at maximum as long as the button is pressed.
Offset Adjustment	Momentarily press the <b>Contrast Adjust</b> button invokes the Zero Calibration routine that is performed immediately prior to each blood pressure measurement. This routine looks at the pressure in the system, and if the pressure is non-zero, an offset is applied which causes the system pressure to display as Zero.

When in the NBP Test screen, the **Return** option is always highlighted. Press the wheel to return to the **Diagnostic Menu**. Rotating the wheel while in the NBP Test screen has no effect.

**CO<sub>2</sub> Test**

The CO<sub>2</sub> Test Screen is provided to facilitate troubleshooting problems and performing verification testing to ensure the measuring results are accurate. See “CO<sub>2</sub> Performance” on page 4-29 for information on how to perform these tests.

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**Warning**

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**A FilterLine, connected to the monitor, should never be applied to a human being while the monitor is in Diagnostic Mode. Injury could result.**

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DIAGNOSTIC MENU	
CO2 TEST	
CO2 Pressure in mmHg (ambient/cell):	745/740
Pump Voltage (Volts):	3.0
CO2 (mmHg):	0.00
Status:	
Set Barometric Pressure (mmHg):	745
Flow Rate Check and Calibration:	
CO2 Calibration:	07/16/2002 15:13
Pump Op Time:	58
Return	

The CO<sub>2</sub> Test Screen is described below:

Menu Item	Function
CO <sub>2</sub> Pressure in mmHg (ambient/cell)	Displays the real-time value of the ambient pressure and the measured cell pressure. The ambient pressure value will be the same as the Barometric Pressure value. This value CANNOT be changed or reset.
Pump Voltage (Volts)	Takes the correct amount of air from outside of the monitor. This value CANNOT be changed or reset.
CO <sub>2</sub> (mmHg)	Displays the real-time value of CO <sub>2</sub> . This value CANNOT be changed or reset.
Set Barometric Pressure (mmHg)	Select a value which matches the reference value received from a reliable source (airport, weather station, hospital weather station). Confirm that the ambient pressure value is the same as the barometric pressure value.
Flow Rate Check and Calibration	Adjust CO <sub>2</sub> flow rate by <b>Decrease Flow</b> or <b>Increase Flow</b> . After desired flow rate is obtained, select <b>Store Flow</b> . Highlight and press <b>Return</b> to exit pop-up menu.
CO <sub>2</sub> Calibration	Displays the date (mm/dd/yyyy) and time that the last calibration occurred.  To calibrate CO <sub>2</sub> , you must first set the percentage of CO <sub>2</sub> , then highlight and press the <b>Start Calibration</b> option. To end calibration, highlight and press <b>Abort Calibration</b> . When calibration is complete, highlight and press <b>Return</b> to exit pop-up menu.
Pump Op Time	Displays how long the pump has been operational. If <b>Make No Change</b> is chosen, Pump Op Time remains at current value. If <b>Reset to Zero</b> is chosen, Pump Op Time has a zero value.
Return	Exits the <b>CO<sub>2</sub> Test</b> and returns to the <b>Diagnostic Menu</b> .

# Restoring Factory Settings

**Caution**

In addition to restoring factory defaults, this procedure clears the contents of trend memory.

The following technique can be used to restore the monitor’s power-up default settings which were originally configured in the factory.

**Note**

Before performing the first step, read this procedure COMPLETELY.

Step	Action																				
1	Ensure that the monitor is powered Off.																				
2	Simultaneously press the <b>Volume</b> and <b>Contrast</b> buttons on the monitor’s front panel.																				
3	Still pressing the <b>Volume</b> and <b>Contrast</b> buttons, press the <b>On/Standby</b> button to turn the monitor On.																				
4	Continue to press the <b>Volume</b> and <b>Contrast</b> buttons until the power-up diagnostic sequence is complete. When the main monitoring screen displays, release the two buttons.																				
5	Select your language from the following screen, then select <b>YES</b> to place the monitor into that language. After language is selected, the main monitoring screen displays. <div><table><tr><td>English</td><td>Nederlands</td></tr><tr><td>中文</td><td>Türkçe</td></tr><tr><td>Français</td><td>العربية</td></tr><tr><td>Deutsch</td><td>Norsk</td></tr><tr><td>Italiano</td><td>Svenska</td></tr><tr><td>日本語</td><td>Suomi</td></tr><tr><td>Português</td><td>Polski</td></tr><tr><td>Español</td><td>Česky</td></tr><tr><td>Русский</td><td></td></tr><tr><td>English</td><td>? Yes</td></tr></table></div>	English	Nederlands	中文	Türkçe	Français	العربية	Deutsch	Norsk	Italiano	Svenska	日本語	Suomi	Português	Polski	Español	Česky	Русский		English	? Yes
English	Nederlands																				
中文	Türkçe																				
Français	العربية																				
Deutsch	Norsk																				
Italiano	Svenska																				
日本語	Suomi																				
Português	Polski																				
Español	Česky																				
Русский																					
English	? Yes																				

# Troubleshooting

This chapter explains how to troubleshoot the monitor if problems arise. Tables are supplied that list possible monitor difficulties, along with probable causes, and recommended actions to correct the difficulty. Use this chapter when you suspect you have a problem with your monitor, or whenever you are referred to this chapter from another part of the Service Guide.

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# General Troubleshooting Safety Information

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**Warning**

**Do not attempt to troubleshoot the monitor if there is any sign of burning or smoking coming from the monitor. Call the Philips Response Center or your local Philips representative immediately.**

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**Caution**

Only qualified service personnel should open the monitor housing, remove and replace components, or make adjustments. If your medical facility does not have qualified service personnel, contact the Philips Response Center or your local Philips representative.

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## Objectives

In order to meet this chapter's objectives, you should be able to diagnose and isolate hardware failures to the level of the "field replaceable part". In addition, this chapter describes how to troubleshoot problems using error codes.

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### Caution

Only qualified service personnel should open the monitor housing, remove and replace components, or make adjustments. If your medical facility does not have qualified service personnel, contact the Philips Response Center or your local Philips representative.

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This chapter is divided as follows:

**Part 1 Troubleshooting Checklist** - This part provides check for the obvious hints and tips.

**Part 2 Solving Monitor Problems** - This part provides the following:

- Tables that list monitor symptoms as well as causes and remedies for monitor faults.
- Techniques for troubleshooting the monitor before you disassemble it.
- Checks you can perform to isolate problems down to a specific replaceable part, for example, the power supply.

**Part 3 Using Support Functions** - This part provides information on how to use error codes as a support feature.

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## Concepts

### Trouble-shooting

This is the essential diagnostic step to be taken prior to any repair.

### Error Codes

These are the types of messages that generate and display to inform the user when the monitor has been unable to perform an operation.

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## Part 1 Troubleshooting Checklist

If any unit is not functioning properly, your first step is to Restore Factory Settings. See *“Restoring Factory Settings” on 5-14* for additional information.

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**Warning**

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**Do not attempt to troubleshoot the monitor if there is any sign of burning or smoking coming from the monitor. Call the Philips Response Center or your local Philips representative immediately.**

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
### Checks for Obvious Problems

When first troubleshooting the monitor, check for obvious problems by answering the following questions:

1. Is the monitor turned On?
2. Is the battery adequately charged?
3. If running from mains power supply, is the AC power cord connected to the monitor and plugged into an AC outlet.

### Checks Before Opening the Monitor

You can isolate many problems by observing indicators on the monitor before it is necessary to open the monitor.

Front Panel LED	Description
AC LED 	On: mains connected, battery charging Off: mains unplugged
Battery LED 	On: DC power on, monitor on Off: DC power off, monitor off

The following two steps are to make sure that the monitor's AC power supply and battery work correctly.

What To Do If The Monitor Cannot Be Switched On, AC Powered:

Step	Action
1	Ensure the battery has had ample time to charge (at least 15 minutes). A dead battery will prevent the monitor from powering On.
2	Check AC fuses in the AC receptacle.
3	Check keypad connector or replace keypad. See <b><i>"Removing the Keypad on the Front Panel" on 7-6</i></b> for instructions.
4	If monitor still cannot be switched On, replace the Main PCB module. See <b><i>"Removing the Main PCB Module" on 7-12</i></b> for instructions.

What To Do If The Monitor Cannot Be Switched On, Battery Powered:

Step	Action
1	Plug the monitor into an AC power source.
2	Ensure the battery has had ample time to charge (at least 15 minutes). A dead battery will prevent the monitor from powering On.
3	Check AC fuses in the AC receptacle.
4	Check keypad connector or replace keypad. See <b><i>"Removing the Keypad on the Front Panel" on 7-6</i></b> for instructions.
5	If monitor still cannot be switched On, replace the Main PCB module. See <b><i>"Removing the Main PCB Module" on 7-12</i></b> for instructions.

## Part 2 Isolating and Solving Monitor Problems

### INOP Messages

The following table explains the technical INOP messages that the monitor can issue, and suggests a course of actions. When actions are numbered, always try them in the order given and only proceed to the next action if the current one is not successful in solving the problem.

Message	Cause of Failure	Remedy
"CO <sub>2</sub> Equip Malf"	Malfunction in the CO <sub>2</sub> hardware.	Verify failure and replace Extension with a known-good Extension.
"CO <sub>2</sub> No Tubing"	The FilterLine is disconnected, or an incorrect line is attached.	Attach a FilterLine. Remember that only Microstream accessories may be used with the monitor.
"CO <sub>2</sub> Sensor Warm-up"	The sensor has not reached operating temperature.	Allow the sensor to warm-up.
"CO <sub>2</sub> Occlusion"	The FilterLine or exhaust tub is blocked to the extent that a measurement sample cannot be taken.  The outlet is occluded at Power On.  This INOP also appears after the Pump Op Time is reset.	Check the FilterLine and exhaust tube, then disconnect and reconnect the FilterLine. If the INOP is still displayed, use a new FilterLine.  If Pump Op Time has been reset, perform a flow check and store the flow in Service Mode (select "Store Flow").
"CO <sub>2</sub> Overrange"	The CO <sub>2</sub> value is outside the measurement range.	
"CO <sub>2</sub> Purging"	The monitor is purging the FilterLine. This occurs when an occlusion is detected in the line or airway adapter. If the occlusion is not removed by purging, a "CO <sub>2</sub> Occlusion" INOP displays.	Check for an occlusion and remove. If necessary, replace the FilterLine.
"CO <sub>2</sub> Auto Zero"	An AutoZero is in progress. An AutoZero will be done at the following intervals: 5 minutes after connecting the FilterLine, 1 hour later, 12 hours later, and every 12 hours from there on.	
"ECG Leads Off"	Not all leads are connected.	Make sure the ECG trunk cable is connected, the leads are connected to the electrodes, and the electrodes are attached. If INOP still displays, use a new lead set.

Message	Cause of Failure	Remedy
"Loss of Pulse from SpO <sub>2</sub> "	SpO <sub>2</sub> cannot find a pulse.	Make sure the SpO <sub>2</sub> patient cable is connected and the sensor is correctly attached to the patient.
"Low Battery"	The battery has less than 30 minutes of charge left.	Recharge the battery.
"NBP - Artifact"	Incomplete measurement due to patient motion or physiology.	<ol style="list-style-type: none"> <li>1. Check the patient.</li> <li>2. Check cuff application and orientation.</li> </ol>
"NBP - Blocked Hose"	NBP tubing blocked - measurement not possible.	Check that the tubing is not obstructed or pinched.
"NBP - No Cuff"	Monitor unable to detect NBP cuff.	<ol style="list-style-type: none"> <li>1. Check to see that cuff is present.</li> <li>2. Check cuff and tube connections for leaks.</li> </ol>
"NBP Overpressure"	This INOP arises when the NBP cuff pressure increases above overpressure safety limits.	Remove the cuff from the patient. Make sure the rubber tube to the NBP cuff is not kinked.
"NBP - Time Out"	NBP measurement took too long to complete.	
"Recorder Out of Paper"	New paper needed.	Replace paper as instructed in the section titled <i>"Recorder Paper Replacement"</i> in the <b>C3 Instructions for Use</b> guide.
"SpO <sub>2</sub> Cable/Sensor Disconnect"	Monitor cannot detect the SpO <sub>2</sub> cable or sensor.	Check that the SpO <sub>2</sub> patient cable is connected and the sensor is properly attached to the patient.
"SpO <sub>2</sub> Equip Malf"	SpO <sub>2</sub> hardware is faulty.	Verify failure and replace SpO <sub>2</sub> module. See <i>"Removing the SpO<sub>2</sub> Module"</i> on page 7-14
"SpO <sub>2</sub> Erratic"	SpO <sub>2</sub> measurement is erratic.	<ol style="list-style-type: none"> <li>1. Make sure the SpO<sub>2</sub> sensor is correctly placed.</li> <li>2. If this does not solve the problem, make sure the sensor is working.</li> </ol>
"SpO <sub>2</sub> Interference"	The level of ambient light is so high that the transducer cannot measure the pulse, or the cable is picking up interference.	<ol style="list-style-type: none"> <li>1. Cover the SpO<sub>2</sub> sensor so that it does not get as much ambient light.</li> <li>2. If this does not solve the problem, make sure the sensor cable is not damaged.</li> </ol>
"SpO <sub>2</sub> No Transducer"	Monitor does not detect SpO <sub>2</sub> sensor.	Make sure the SpO <sub>2</sub> sensor is connected.

Message	Cause of Failure	Remedy
"SpO <sub>2</sub> Noisy Signal"	Excessive patient movement or electrical interference are causing irregular pulse patterns.	Try to reduce patient movement, or to relieve the cable strain on the sensor.
"SpO <sub>2</sub> Non-Pulsatile"	Pulse is too weak or is not detectable, or the application site is too thin.	Change the application site of the sensor, or stimulate circulation at the current site.
"SpO <sub>2</sub> Transduc Malf"	Sensor is malfunctioning.	<ol style="list-style-type: none"> <li>1. Change the SpO<sub>2</sub> sensor as soon as possible.</li> <li>2. Return the faulty sensor to your biomedical department.</li> </ol>
"Temperature Probe Disconnect"	Monitor is not detecting temperature reading.	Check that the temperature probe is properly connected to the monitor.

## Isolating the Defective Component

You can use the following table to isolate and solve problems which may occur in the monitor.

Symptom	Cause of Failure	Remedy
The battery symbol is not displayed	A battery is not present in the monitor, the battery is defective, or there is a bad connection.	Install a charged battery (see " <i>Removing the Battery</i> " on page 7-4). If a battery is already present, remove it and refit the battery making sure to push is completely into position. Check the connection wires to make sure wires are secured to battery.
Some or all numerics or waves are not displayed	Parameters are switched off. No accessories are connected.	Switch parameters on. Connect the required accessories. If connections are secure, replace the suspect accessory.
Monitor screen appears dim	Brightness not properly adjusted. Display backlight tube worn.	Adjust brightness using <b>Contrast</b> button. Replace backlight tube according to instructions in " <i>Replacing the Backlight Tube</i> " on page 7-9.
Monitor screen is blank	Display backlight tube worn or loose connection.  Main PCB module malfunction.	<ol style="list-style-type: none"> <li>1. Check the backlight tube connector</li> <li>2. Replace the backlight tube</li> </ol> Replace the Main PCB module according to instructions in " <i>Removing the Main PCB Module</i> " on 7-12.

Symptom	Cause of Failure	Remedy
Monitor fails to power-up when the <b>On/Standby</b> button is pressed.	Battery is dead or monitor is not plugged in.  Keypad malfunction or keypad connector is loose.	Make sure the monitor is powered on by either battery or AC power. Check that the battery is adequately charged and AC power fuses are securely connected.  1. Check the keypad connector. 2. Replace the keypad according to the instructions in <b><i>“Removing the Keypad on the Front Panel” on 7-6.</i></b>
No response when pressing the buttons on the front panel	Keypad malfunction or keypad connector is loose.	1. If only one button does not work, verify that the monitor is On. 2. Check the keypad connector 3. Replace the keypad according to the instructions in <b><i>“Removing the Keypad on the Front Panel” on 7-6.</i></b>
Audible alarm does not sound	Speaker malfunction or speaker has a loose connector.  Main PCB module malfunction.	1. Check speaker connector. 2. Replace speaker according to the instructions in <b><i>“Replacing the Speaker” on 7-9.</i></b>  Replace the Main PCB module according to the instructions in <b><i>“Removing the Main PCB Module” on 7-12.</i></b>
All patient data is lost or corrupted (indicated in the error log)	Occurs when more than 15 minutes has elapsed when replacing the battery.	If this occurs, replace the Main PCB module according to the instructions in <b><i>“Removing the Main PCB Module” on 7-12</i></b>
Recorder is not printing	Defective recorder.	Check that the recorder is correctly installed and there is paper in the recorder. If problem still exists, replace recorder according to the instructions in <b><i>“Removing the Optional, External Recorder” on page 7-6.</i></b>
Recorder paper will not advance	Paper is in incorrectly.  Defective recorder.	Replace paper as instructed in the section titled <b><i>“Recorder Paper Replacement”</i></b> in the <b>C3 Instructions for Use</b> guide.  Check that the recorder is correctly installed and there is paper in the recorder. If problem still exists, replace recorder according to the instructions in <b><i>“Removing the Optional, External Recorder” on page 7-6.</i></b>

## Part 2 Isolating and Solving Monitor Problems

Symptom	Cause of Failure	Remedy
No sound from monitor	Tone is switched off or low.	<ol style="list-style-type: none"> <li>1. Turn the volume up by pressing the <b>Volume</b> button.</li> <li>2. Power-cycle monitor. Tone should sound when monitor boots up.</li> <li>3. Check cable connections to the speaker.</li> </ol>
Incorrect Time Stamps  Invalid data stored showing wrong times for data	The monitor's real time clock is defective.	Power the monitor On and then reset the time and date. See the <b>C3 Instructions for Use</b> guide for instructions on how to set the date and time.
Cannot reprogram the time and date correctly	Main PCB module malfunction.	Replace the Main PCB module according to the instructions in <b><i>"Removing the Main PCB Module" on 7-12.</i></b>
Fluid dripping from the monitor	LCD Display damaged or cracked.	Replace LCD Display.
Decrease in light intensity on display.  Brightness decreases from top to bottom or bottom to top.	Backlight tube is worn out.	Replace backlight tube according to instructions in <b><i>"Replacing the Backlight Tube" on page 7-9.</i></b>
No tone alarms	Audible alarms are not switched on.	Make sure audible alarms are switched on.
Speaker will not work	Cable disconnected.  Defective speaker.	Reconnect cable.  Replace speaker.
The wheel is rotated, no highlight appears on the display screen, and/or the monitor does not respond to wheel presses.	Main PCB module malfunction.	Replace the Main PCB module according to the instructions in <b><i>"Removing the Main PCB Module" on 7-12.</i></b>



## Part 3 Using Support Functions

When the monitor detects an error condition, the monitor shows an error code on the display screen. If such an error occurs during monitoring operation, an audible alarm tone also sounds. Press the **Alarm Silence** button to terminate the audible alarm tone.

When an error code appears on the display, a number in hexadecimal representation indicates the nature of the error. Additionally, Diagnostic Mode can be used to gain access to an error code record, stored in non-volatile memory, of the last 10 error codes encountered. See **Chapter 5 Diagnostic mode** for further details on Diagnostic Mode.

Each error code corresponds to a particular problem in the monitor. Recommended actions to take when an error code is encountered are listed below.

### Serviceable Hardware Error Codes

Listed below are error codes that correspond to hardware problems, and the recommended actions to take should such an error be encountered.

Hex Code	Explanation	Recommended Action
1	Improper shutdown	<ol style="list-style-type: none"> <li>1. Power cycle</li> <li>2. If this error persists, return the monitor to your local Philips representative for service.</li> </ol>
4	The measure valve of the 3.3V power supply is low.	<ol style="list-style-type: none"> <li>1. Check the power supply.</li> <li>2. Replace the power supply module.</li> </ol>
5	The measured valve of the 3.3V power supply is high.	<ol style="list-style-type: none"> <li>1. Check the power supply.</li> <li>2. Replace the power supply module.</li> </ol>
8	The measured value of the 5V power supply is low.	<ol style="list-style-type: none"> <li>1. Check the power supply.</li> <li>2. Replace the power supply module.</li> </ol>
9	The measured value for the 5V power supply is high.	<ol style="list-style-type: none"> <li>1. Check the power supply.</li> <li>2. Replace the power supply module.</li> </ol>
E	A checksum error is detected on the power-up settings region of flash memory.	<ol style="list-style-type: none"> <li>1. Turn power Off</li> <li>2. Turn power On while pressing both the Contrast and Volume buttons simultaneously. (See <i>"Restoring Factory Settings"</i> on page 5-14.)</li> <li>3. All user selections must be restored.</li> <li>4. If problem persists, replace main PCB module.</li> </ol>

Hex Code	Explanation	Recommended Action
64	The SpO <sub>2</sub> module is sending an error message to the host CPU.	<ol style="list-style-type: none"> <li>1. Ensure PicoSat module is properly connected.</li> <li>2. Replace the PicoSat module.</li> <li>3. If problem persists, replace main PCB module.</li> </ol>
?	The CO <sub>2</sub> module is sending an error message to the host CPU.	<ol style="list-style-type: none"> <li>1. Ensure Oridion module is properly connected.</li> <li>2. Rplace the Oridion module.</li> <li>3. If problem persists, replace main PCB module.</li> </ol>
65, 66	PicoSat SpO <sub>2</sub> module has detected an error during initialization.	<ol style="list-style-type: none"> <li>1. Replace PicoSat module.</li> <li>2. If problem persists, replace main PCB module.</li> </ol>
6E-71	PicoSat SpO <sub>2</sub> module has detected an error on its serial port.	<ol style="list-style-type: none"> <li>1. Replace PicoSat module.</li> <li>2. If problem persists, replace main PCB module.</li> </ol>

## Error Code Categories

As a reference, the following table lists the general categories for other error codes. The error code categories are shown only in hexadecimal format.

Hexadecimal Code	Explanation
500xxx	internal user interface error
501xxx	remove serial port error
502xxx	date and time error
503xxx	NBP error
504xxx	front end error
505xxx	alarm error
506xxx	audio error
507xxx	recorder error
508xxx	trend error
509xxx	flash memory data error
50axxx	SpO <sub>2</sub> error
50bxxx	ECG error
50cxxx	power-down task error
50dxxx	on-board diagnostic error
50exxx	power monitor error
50fxxx	temperature measurement error
510xxx	internal user interface error
511xxx	error handling error
513xxx	serial driver error

Hexadecimal Code	Explanation
514xxx	system error
515xxx	CO <sub>2</sub> error

## Other Error Codes

If an error code occurs that is not listed in the above sections, take the following actions:

Step	Action
1	Power cycle the monitor.
2	If the error code still displays, take the monitor out of service and contact the Philips' Response Center or your local Philips representative for advice on remedial action.
3	If the monitor powers up and the error code does not reoccur, enter the <b>Diagnostic Mode</b> and select the <b>Error Code</b> option. Examine the record of the last 10 error codes and determine if the same error code occurred previously.
4	If the Error Code screen indicates that the same error code has occurred previously, take the monitor out of service and contact the Philips' Response Center or your local Philips representative for advice on remedial action.
5	If the Error Code screen indicates no previous occurrences of this error, the monitor can be returned to service.



# Disassembly

This chapter provides step-by-step procedures that are used to access replaceable parts of the monitor. The sections in this chapter describe and photographically illustrate procedures for disassembling the monitor in order to remove or replace suspected defective assemblies or components.

---

## Introduction

The monitor consists of two main assemblies, the front case assembly, and the rear case assembly.

All part numbers and exploded views of some assemblies are located in *Chapter 8, "Spare Parts" on page 8-1*. The monitor can be disassembled down to all major component parts, including

- PCBs
- Battery
- Cables
- Function buttons
- Chassis enclosures

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## Tools Required

You will need the following tools to disassemble the monitor:

- small/medium, Philips-head screwdriver
- flathead screwdriver
- needle-nose pliers
- 10 mm socket wrench (for navigation wheel)
- 5/16 nut driver

*Note—If you want to disassemble the RS-232 connector located on the rear panel, you will need a 3/16 inch socket wrench.*

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## Disassembly Safety Information

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### **Warning**

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**Performance Verification:** Do not place the monitor into operation after repair or maintenance has been performed, until all recommended Performance and Safety Tests listed in *Chapter 4, "Testing the Monitor"* of this Service Guide have been performed. Failure to perform all tests could result in erroneous monitor readings.

**Before attempting to open or disassemble the monitor, disconnect the power supply from the monitor.**

**Before you begin any disassembly procedure, you must remove the battery.**

**High voltage is generated by the LCD backlight driver. Exercise caution when operating the monitor with the covers open.**

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### **Caution**

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Observe ESD (electrostatic discharge) precautions when working within the unit.

Before you remove any module, make sure you are wearing ESD protection and you are working in a grounded environment.

If the internal battery cable has been disconnected, pay particular attention to the polarity of the cable before reattaching. If the battery cable polarity is reversed, it is likely that circuit damage will occur.

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*Note—If you want to disassemble the RS-232 connector located on the rear panel, you will need a 3/16 inch socket wrench.*

---

# Disassembly Procedures

This section provides instructions for closed case, front case and rear case disassembly procedures.

## Closed Case Disassembly Procedures

This section describes the items that can be removed without disassembling the main case of the monitor.

### Removing the Battery


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**Warning**

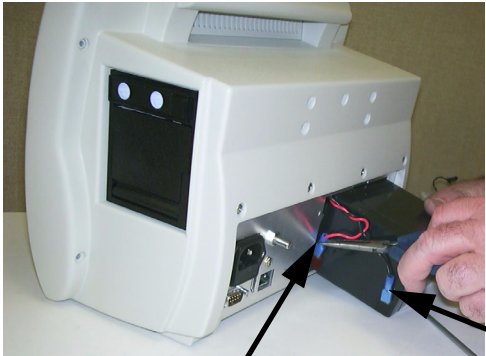
---

**Before you begin any disassembly procedure, you must remove the battery.**

---

Step	Action
1	<div>With the rear of the monitor facing you, disconnect the battery cover from the rear panel using a Philips no. 1 screwdriver to loosen the 4 captive screws fastening the battery cover.</div> <div></div>
2	<div>Slide the battery out by tilting the monitor towards you.</div>




Step	Action
3	Disconnect both battery lug terminals to release the battery.
4	<div>When you re-insert the battery, verify that the battery is inserted the correct way and the polarity is correct (see figure below).</div> <div><p>Red</p><p>Black</p></div>


**Removing the  
Navigation  
Wheel**

Step	Action
1	Firmly grasp both sides of the wheel and pull straight back from the monitor. The wheel should slip off the encoder shaft. If the wheel does not slip off the encoder shaft, use the needle-nose pliers and pull the wheel.
2	For further disassembly, use the 10 mm socket wrench to unscrew the brass hex nut.


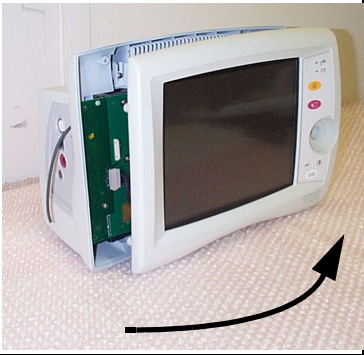
**Removing the Keypad on the Front Panel**

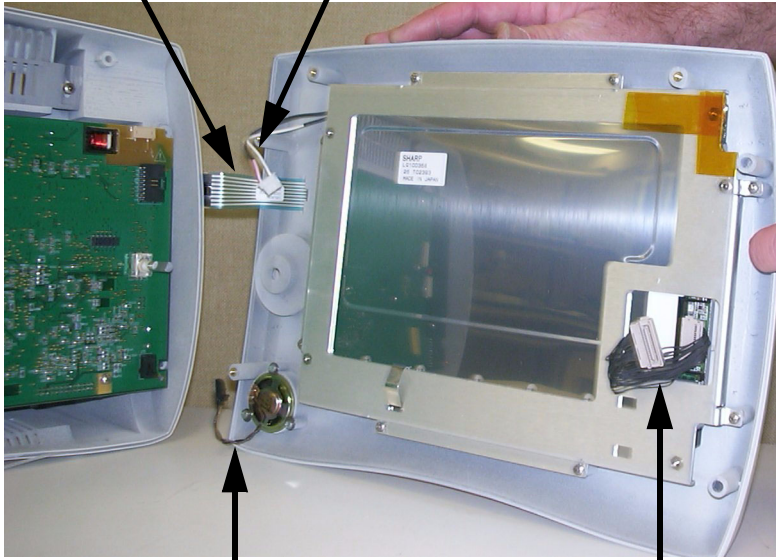
Step	Action
1	The keypad is attached with an adhesive to the front panel. To remove it, carefully lift up one corner of the keypad with a flathead screwdriver.
2	Peel the adhesive away from the front panel. <div data-bbox="594 529 992 928"></div>

**Removing the Optional, External Recorder**

Step	Action
1	Press the external Paper Eject button on the right hand side of the recorder. The door drops forward.
2	Remove the paper roll. Two secure screws are visible on the back panel of the recorder.
3	Use a Philips screwdriver to loosen the two captive screws. <div data-bbox="586 1316 1024 1724"></div>
4	Pull the recorder straight out of the side of the monitor by placing your index and middle fingers in the inside center of the recorder and firmly pulling the recorder towards you.

Separating  
the Front  
from the  
Rear Case

Step	Action
1	Verify that the battery has been removed. If not see, <i>“Removing the Battery on page 7-4.</i>
2	Verify that the navigation wheel and brass hex nut have been removed. If not see, <i>“Removing the Navigation Wheel on page 7-5.</i>
3	Use a Philips no. 2 screwdriver to remove the 6 screws fastening the Rear Case Assembly to the Front Case Assembly. <div data-bbox="982 632 1474 1031"></div>
4	Facing the front of the monitor, shift the front case slightly to the right, making sure that you do not break off the navigation wheel shaft. <div data-bbox="1112 1146 1474 1497"></div>

Step	Action
5	<p>Disconnect the display cable located on your left-hand side by pulling the connector towards you. Disconnect the backlight tube, front panel and speaker cables located on your right-hand side.</p> <div><div>Front Panel Cables</div><div>Backlight Tube Cables</div><div>Speaker Cable</div><div>Display Cable</div></div>
6	Separate the front from the rear case.

Front Case  
Disassembly

- After you have separated the front from the rear case you can replace the following from the front case assembly:
- Speaker
  - Backlight Tube

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**Caution**

---

Before you remove any module, make sure you are wearing ESD protection and you are working in a grounded environment.

---

**Replacing the Speaker**

Step	Action
1	Use a Philips no. 2 screwdriver to remove the 3 screws fastening the speaker. <div data-bbox="1003 466 1474 760"></div>
2	Pull the speaker up.

**Replacing the Backlight Tube**

The backlight tube is located within the LCD screen. However, you do not need to disassemble the LCD screen display to replace the backlight tube.

Step	Action
1	Insert a small, thin, flathead screwdriver into the crevice between the LCD screen and where the backlight tube slides in. <div data-bbox="948 1163 1474 1432"></div>
2	Using the screwdriver, grab the corner of the backlight tube and gently pull the tube out. Re-insert a new backlight tube. <div data-bbox="1005 1547 1474 1862"></div>

**Rear Case  
Disassembly**


You must disassemble the rear case to remove the following modules:

- Main PCB
- Patient Monitoring I/O
- SpO<sub>2</sub>
- CO<sub>2</sub>
- NBP
- Communications
- Power Supply

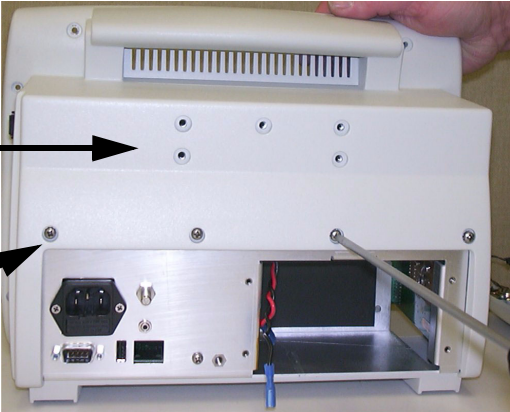
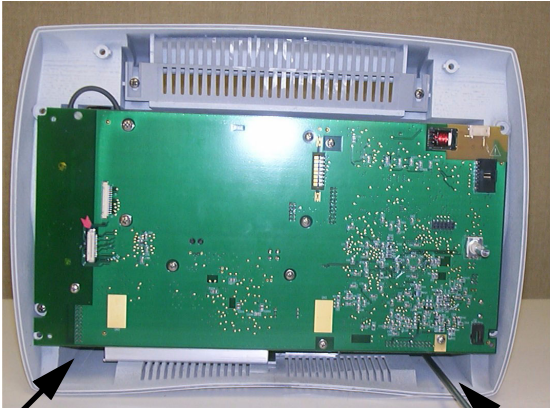
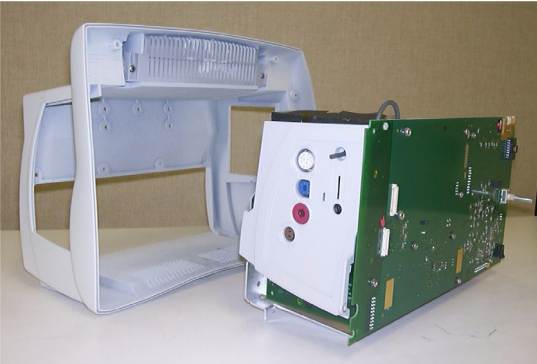
**Caution**

Before you remove any module, make sure you are wearing ESD protection and you are working in a grounded environment.

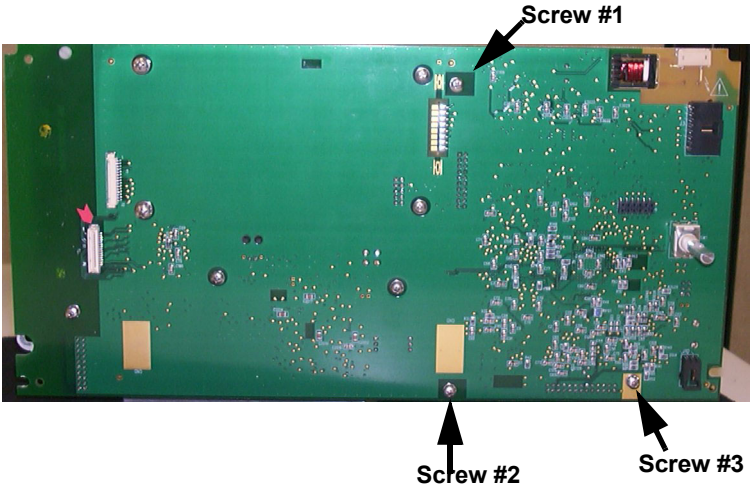
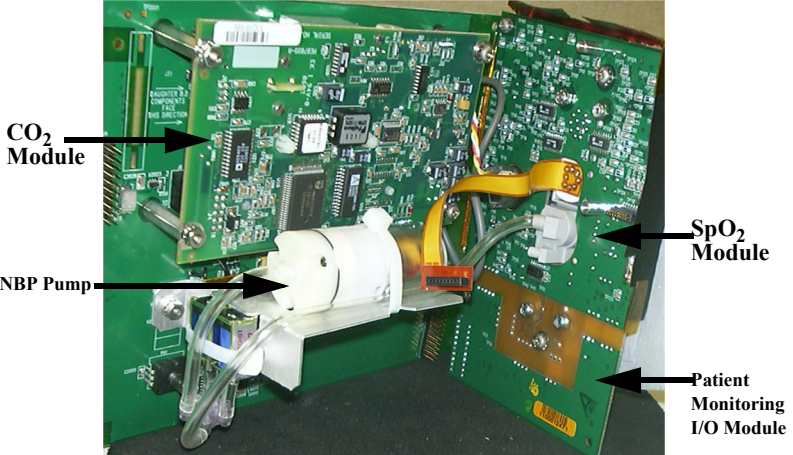
To disassembly the rear case:

Step	Action
1	Verify that the battery has been removed. If not see, <i>“Removing the Battery on page 7-4.</i>
2	Verify that the recorder has been removed. If not see, <i>“Removing the Optional, External Recorder on page 7-6.</i> If there is no recorder, unsnap the recorder door using a flathead screwdriver (see figure below). 



Step	Action
3	<p>Use a Philips no. 2 screwdriver to remove the 9 screws fastening the rear case.</p>  <p>The image shows the rear of a white electronic device. A hand is holding a screwdriver to remove a screw from the top panel. Two arrows point to specific screw locations: one labeled 'Screws 1-5' points to the top panel, and another labeled 'Screws 6-9' points to the lower section of the rear case.</p>
4	<p>Remove the two screws located in the bottom corners of the rear case.</p>  <p>The image shows the interior of the rear case with a green circuit board. Two arrows point to screws at the bottom corners: 'Screw 1' on the left and 'Screw 2' on the right.</p>
5	<p>Gently slide the chassis away from the rear case.</p>  <p>The image shows the white rear case on the left and the green circuit board (chassis) being pulled away from it on the right.</p>

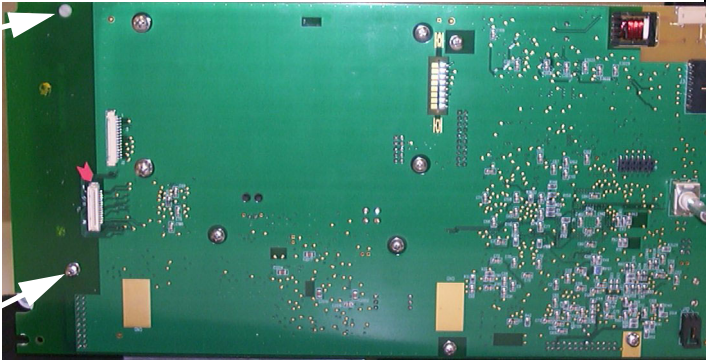
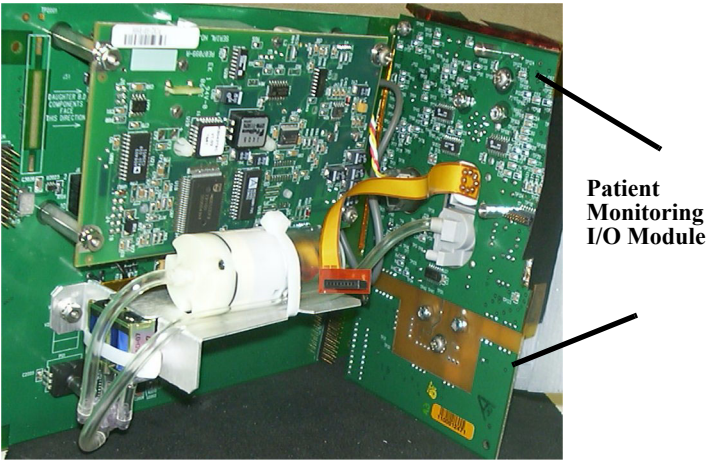
Removing the Main PCB Module

Step	Action
1	<p>Unscrew the PCB module by loosening the following 3 screws:</p> 
2	<p>Gently pull the module towards you.</p>
3	<p>After you have removed the Main PCB module, you should have access to the CO<sub>2</sub>, SpO<sub>2</sub>, NBP pump, and the Patient Monitoring I/O modules.</p> 



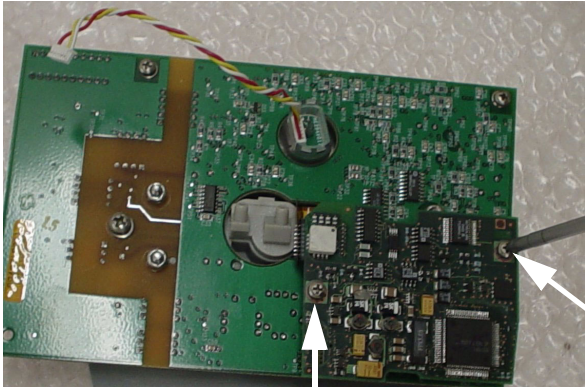
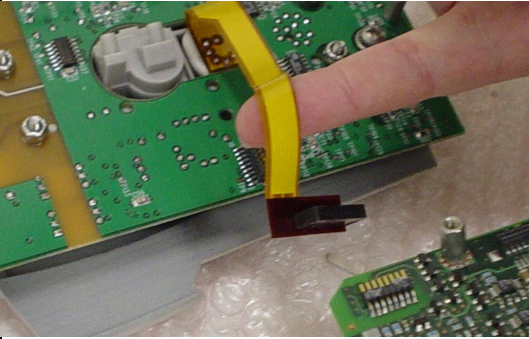
**Removing the  
Patient  
Monitoring I/O  
Module**

Follow these instructions for removing the I/O module from the Main PCB module.

Step	Action
1	<div>Remove the following 2 screws to remove the connector module.</div> <div><div><div>Screw #1</div><div>Screw #2</div></div></div> <div><i>Note—Use a flathead screwdriver to remove Screw #1.</i></div>
2	Slide the I/O module out.
3	Disconnect the CO <sub>2</sub> connector and tubing and the NBP tubing. Slide the CO <sub>2</sub> exhaust tubing out.
4	<div>Pull the I/O module away.</div> <div></div>

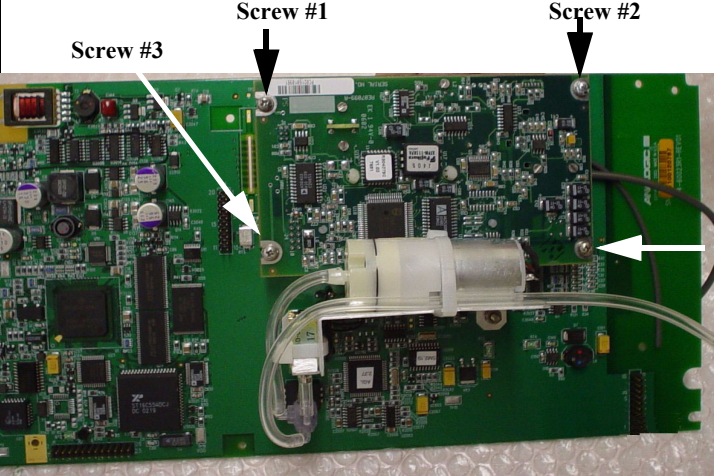
**Removing the SpO<sub>2</sub> Module**

After you have removed the Patient Monitoring I/O module from the Main PCB module, you can remove the SpO<sub>2</sub> module. To do this:

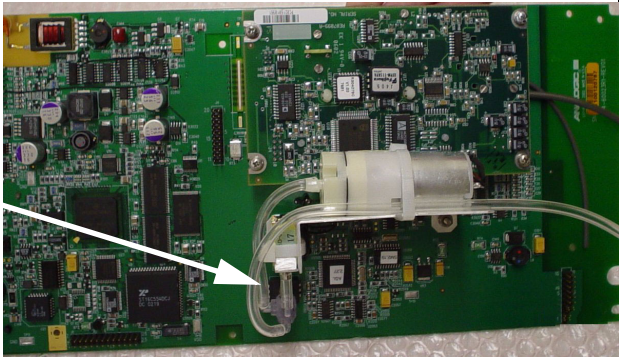
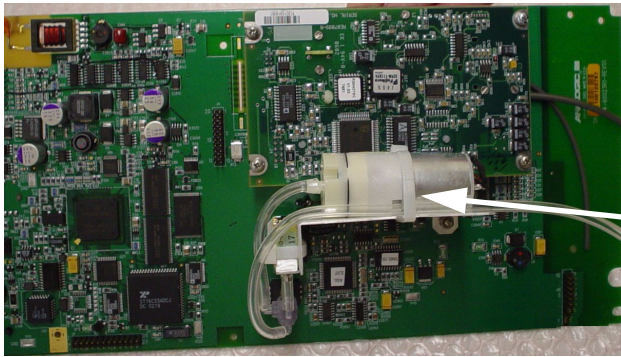
Step	Action
1	<div>Remove the 2 screws fastening the SpO<sub>2</sub> module to the I/O module.</div> <div></div>
2	<div>Remove the connector that attaches the SpO<sub>2</sub> module to the I/O module.</div> <div></div>
3	<div>Gently pull the SpO<sub>2</sub> module away.</div>

Removing the  
CO<sub>2</sub> Module

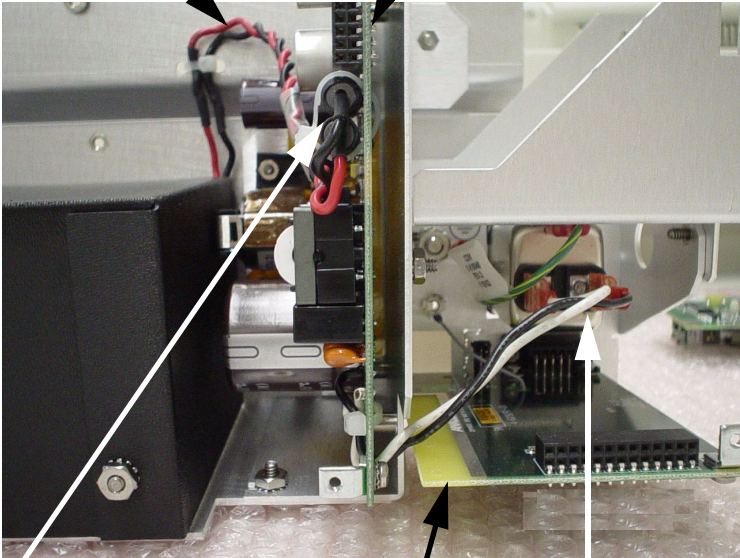
*Note—This procedure is only for those that have the C3 Sedation model.*

Step	Action
1	<div>Remove the 4 screws on the CO<sub>2</sub> module.</div> <div></div>
2	<div>Tilt the CO<sub>2</sub> module towards the NBP pump.</div>
3	<div>Gently pull the module away from the Main PCB module.</div> <div><i>Note—When reassembling the CO<sub>2</sub> module, ensure that the CO<sub>2</sub> header matches up with the mating header.</i></div>

Removing the  
NBP Pump

Step	Action
1	Remove the connector from the NBP pump. <div></div>
2	Cut the tie wrap. <div></div>

Removing the  
Power Supply  
Module

Step	Action
1	<div>Use the needle-nose pliers to unplug the three connectors.</div> <div><p><b>Battery Cables</b></p><p><b>Power Supply Board</b></p><p><b>Connector #1</b></p><p><b>Communications Module</b></p><p><b>Connectors #2 &amp; 3</b></p></div>
2	Remove the two screws that connect the power supply to the rear panel.
3	Remove the screws on the side and bottom of the rear panel.
4	Cut the tie wrap that holds the battery cables together.
5	Use a 5/16 nut driver to unfasten the power supply from the rear panel.
6	Pull the power supply module away from the rear panel.





# Spare Parts

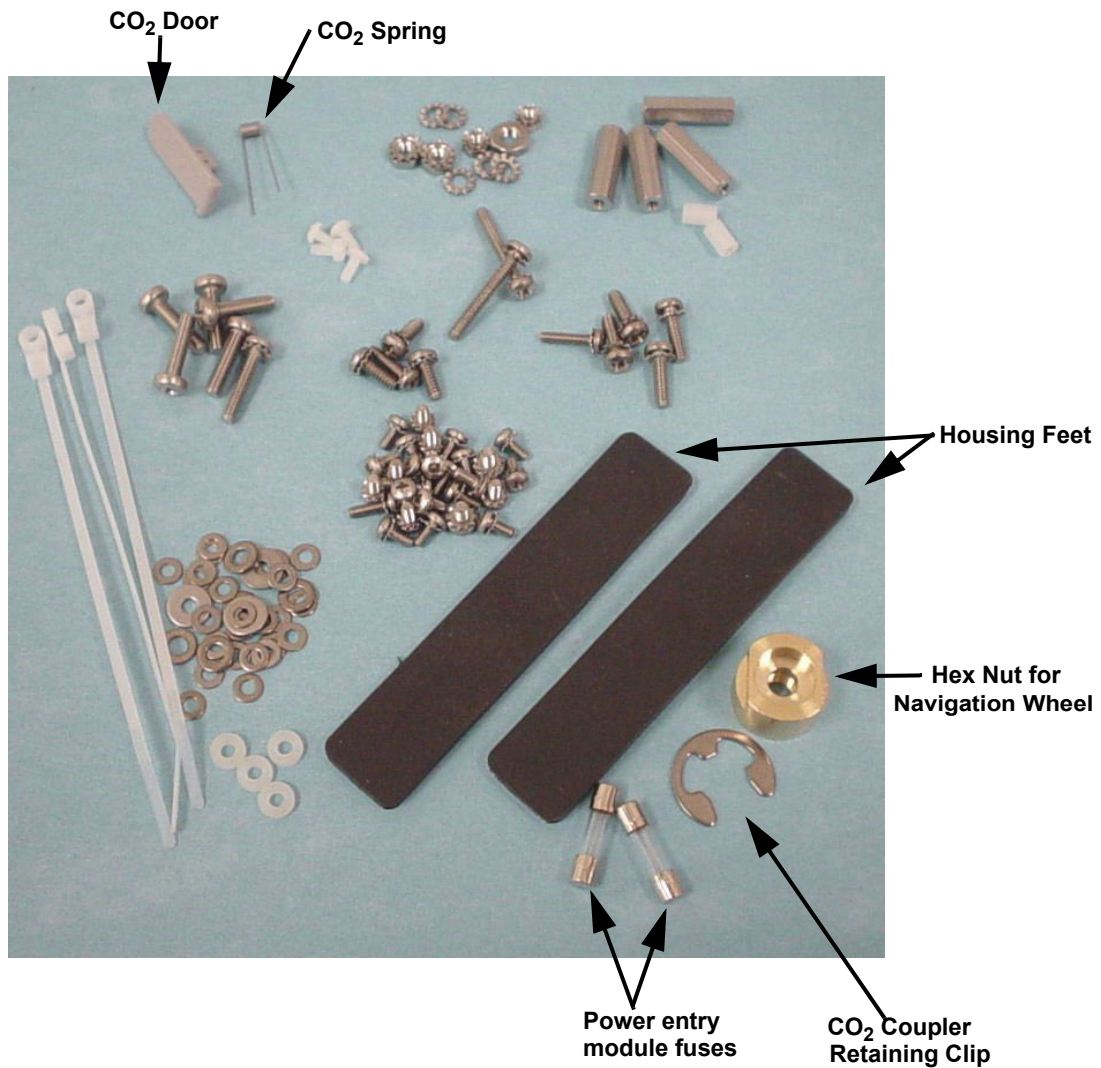
This chapter lists spare parts, along with part numbers, are listed in the tables that follow.

**Item No.** corresponds to the callout number in Figure 8-1 through 8-6. the **Page Ref. for Disassembly** indicates the page number of the relevant disassembly procedures in *Chapter 7, "Disassembly"*.

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## Small Parts Kit

Most small parts and hardware (screws, hex nuts, washers, standoffs, 2 fuses, CO<sub>2</sub> spring and door, and 2 housing feet) can be found in the Small Parts Kit, Part Number 453563480201. The picture below calls out a few of the less commonly known parts within this kit.





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## C3 Top Level Assembly

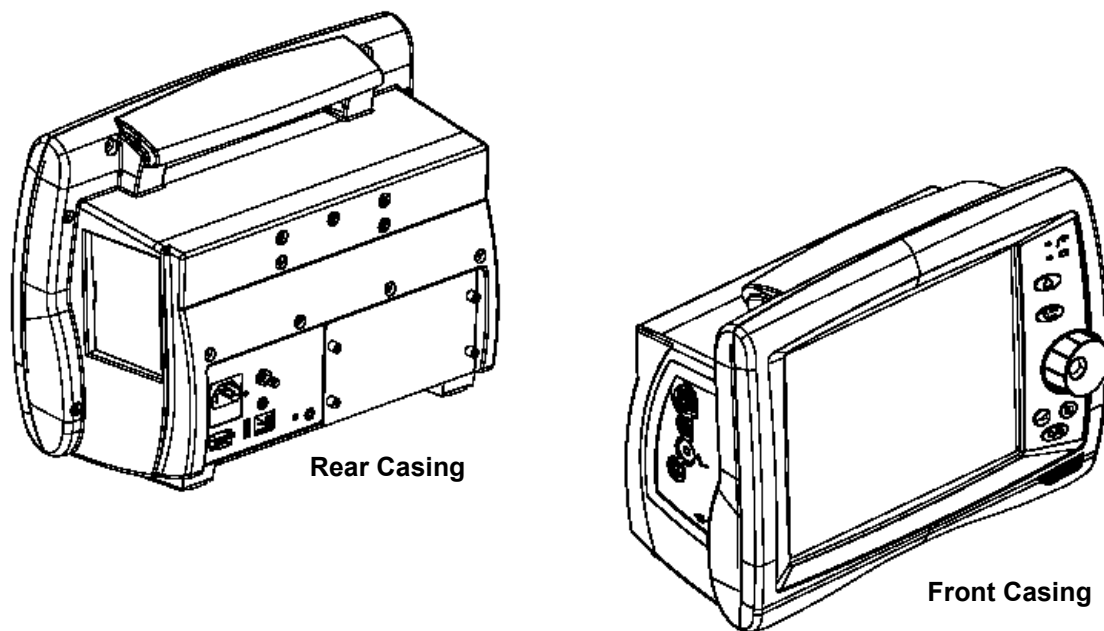


Figure 8-1

# Front Panel Assembly

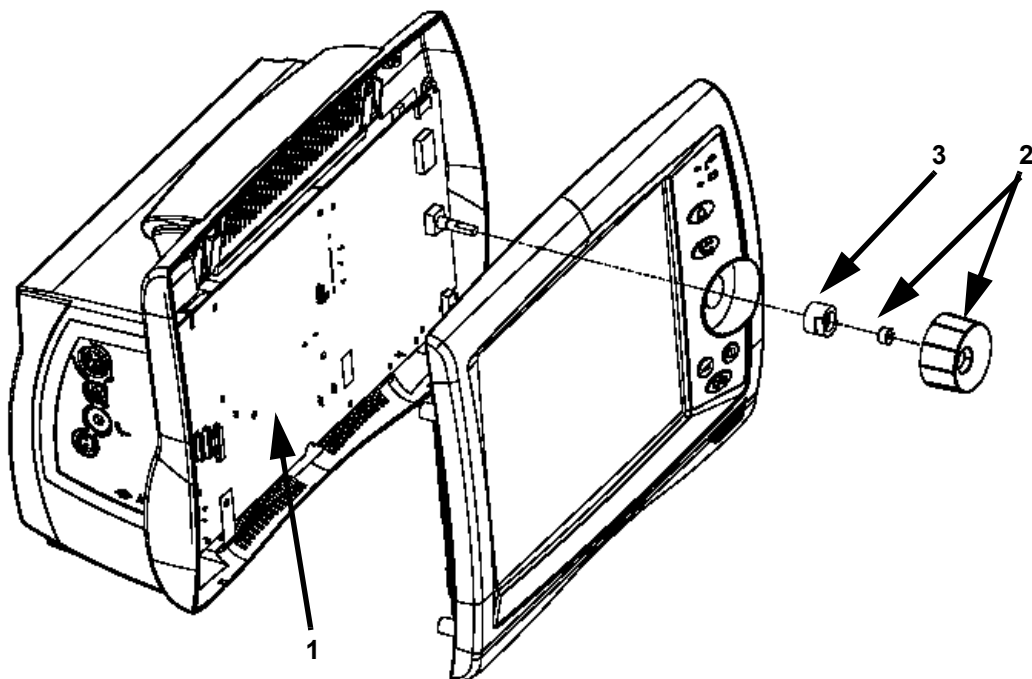


Figure 8-2 (1 of 2)

Item No.	Part Number	Description	Page Ref. for Disassembly
1	453563480151	Main PC Board	<i>page 7-12</i>
2	453563480111	Navigation Wheel and Retainer Spring	<i>page 7-5</i>
3	453563480201 (Spare Parts Kit)	Hex Nut	<i>page 7-5</i>

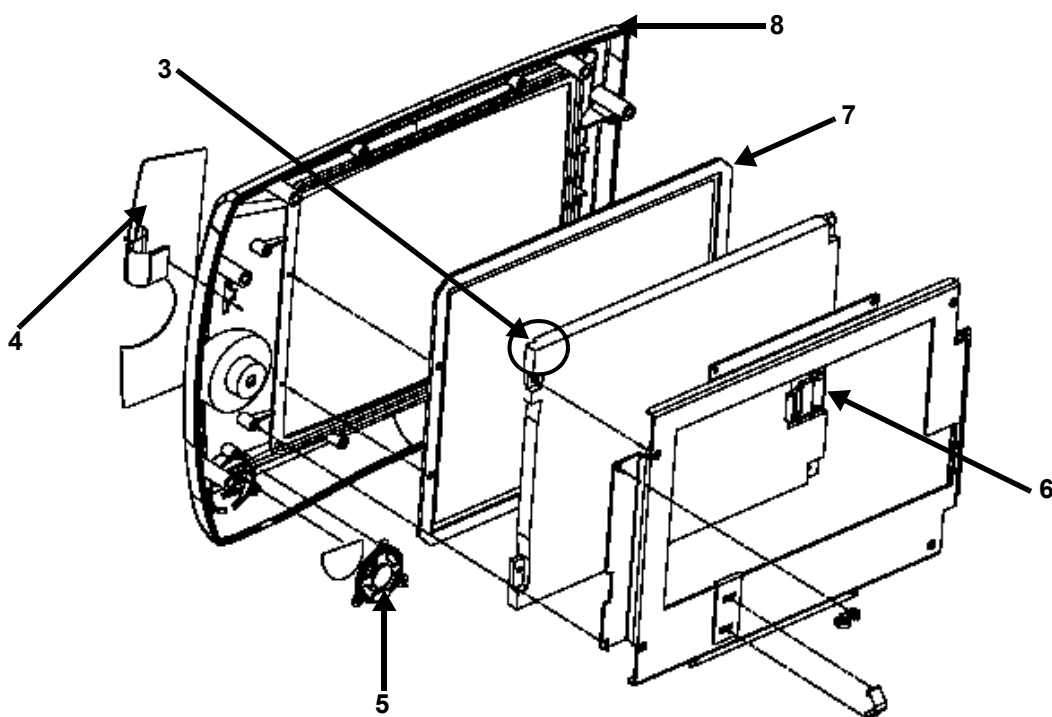


Figure 8-3 (2 of 2)

Item No.	Part Number	Description	Page Ref. for Disassembly
3	453563480021	Backlight Tube	<i>page 7-9</i>
4	453563480101	Keypad	<i>page 7-6</i>
5	453563480221	Speaker (including speaker cable)	<i>page 7-9</i>
6	453563480081	Display Cables	<i>page 7-7</i>
7	453563480051	Bezel Protective Window Display	No Disassembly Procedure
8	453563480091	Front Housing	No Disassembly Procedure

Rear Panel Assembly

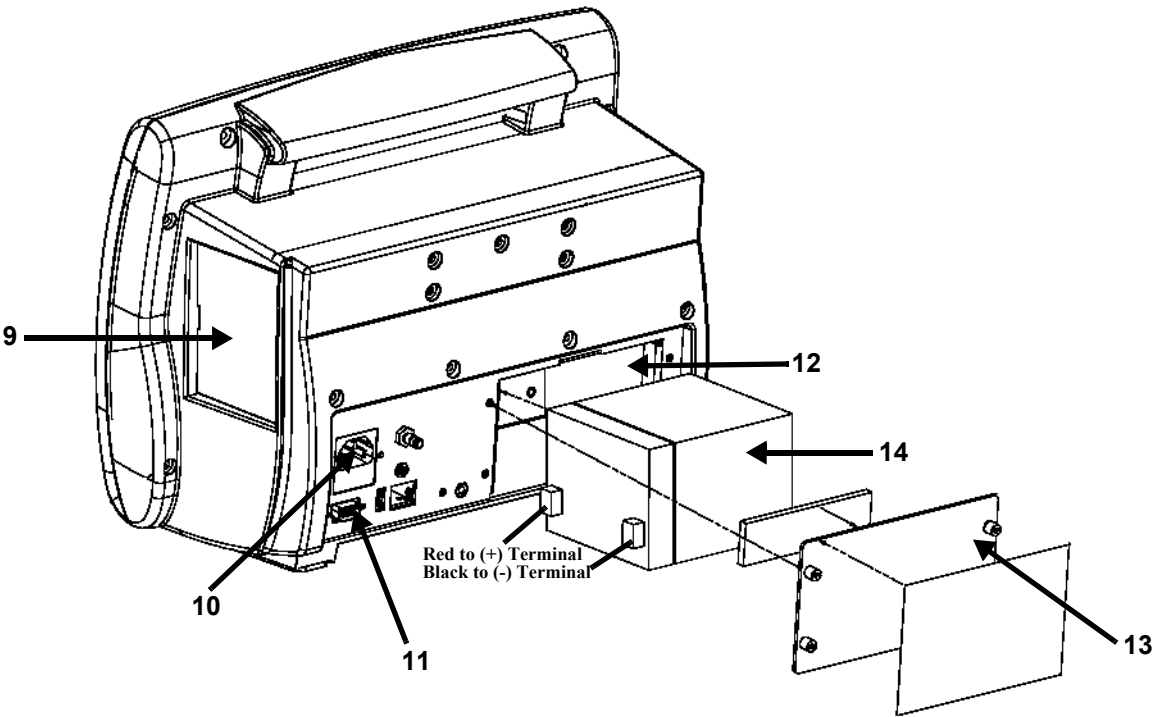


Figure 8-4 (1 of 3)

Item No.	Part Number	Description	Page Ref. for Disassembly
9	453563480211	Spare Recorder Blanking Plate	<i>page 7-6</i>
10	453563480011	AC Connector, Power Entry Module	No Disassembly Procedure
11	453563480171	RS-232 Port	No Disassembly Procedure
12	453563480041	Battery Housing	<i>page 7-4</i>
13	453563480071	Battery Cover	<i>page 7-4</i>
14	453563480031	Battery	<i>page 7-4</i>

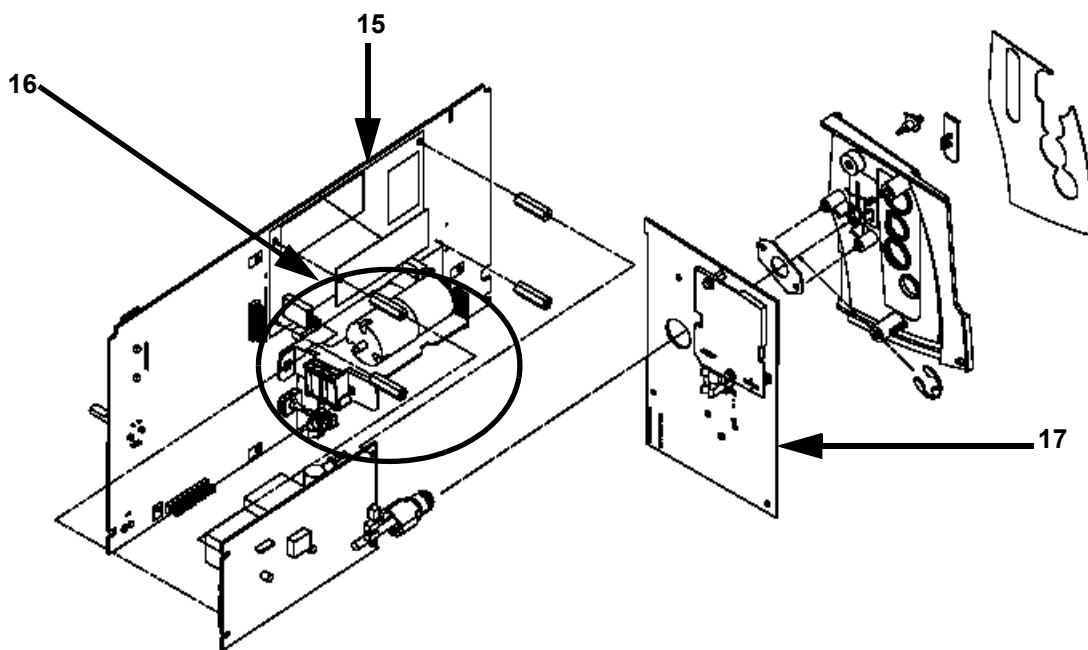


Figure 8-5 (2 of 3)

Item No.	Part Number	Description	Page Ref. for Disassembly
15	453563480191	Side Panel - with CO <sub>2</sub>	<i>page 7-15</i>
Not Shown	453563480181	Side Panel - without CO <sub>2</sub>	No Disassembly Procedure
16	453563480121	NBP Assembly	<i>page 7-16</i>
16	453563480131	NBP Cable	<i>page 7-16</i>
17	453563480141	Patient Monitoring I/O Module	<i>page 7-13</i>

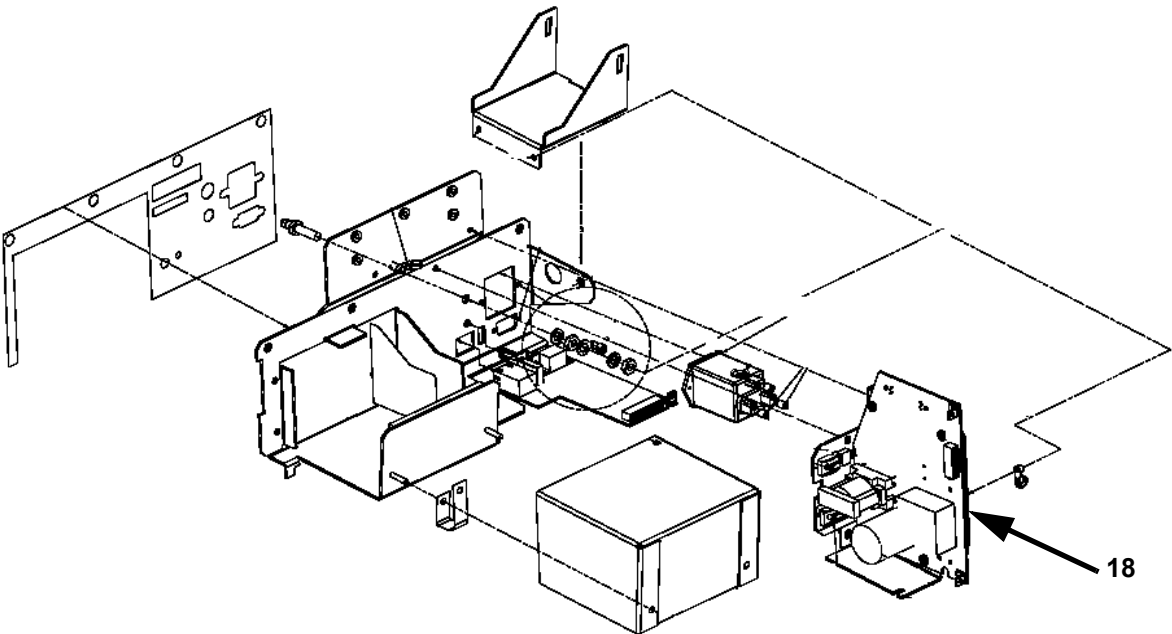


Figure 8-6 (3 of 3)

Item No.	Part Number	Description	Page Ref. for Disassembly
18	453563480161	Power Supply Board	page 7-17
Not Shown	453563480061	Communication Board	page 7-17

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## Power Cords

Part Number	Description
8120-5429	Power Cord, US (903) 2.4 m
8120-1689	Power Cord, Europe (902) 2.0 m
8120-1351	Power Cord, UK (900) 2.3 m
8120-4475	Power Cord, Australia (901) 2.0 m
8120-2104	Power Cord, Switzerland (906) 2.0 m
8120-2956	Power Cord, Denmark (912) 2.0 m
8120-4211	Power Cord, South Africa/India (917) 2.0 m
8120-5342	Power Cord, Japan (918) 2.5 m
8120-5182	Power Cord, Israel (919) 2.0 m
8120-6869	Power Cord, Argentina (920) 2.0 m
8120-6980	Power Cord, Chile (921) 2.0 m
8120-8376	Power Cord, China (922) 2.0 m

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## Exchange Unit Part Numbers

Exchange Unit Part Number	Description
453563344311	Thermal Recorder for C3 Patient Monitor GSI
453563480441	Exchange Recorder for C3 Patient Monitor GSI
453563480381	C3 Standard Color Monitor
453563480401	C3 Standard Color Monitor with Recorder
453563480411	C3 Sedation Color Monitor
453563480431	C3 Sedation Color Monitor with Recorder



# Packing for Shipment

This chapter explains how to pack the monitor for shipment for any reason.

---

## General Instructions

To ship the monitor for any reason, follow the instructions in this section.

To pack the monitor for return, disconnect all cables. It is not necessary to return sensors, patient cables, NBP tubing and cuff or power cord. Pack the monitor carefully. Failure to follow the instructions in this section can result in loss or damage not covered by the warranty. If the original shipping carton is not available, use another suitable carton.

Prior to shipping the monitor, contact the Philips Response Center for a RGA (Returned Goods Authorization) number. Mark the shipping carton and any shipping documents with the RGA number.

---

## Repacking the Original Carton

If available, use the original carton and packing materials. Pack the monitor as follows:

Step	Action
1	Place the monitor, and if necessary, accessory items in original packaging.
2	Place the shipping carton and seal carton with packaging tape.
3	Label carton with shipping address, return address and RGA number, if applicable.

---

## Repacking in a Different Carton

If the original carton is not available, use the following procedure to pack the monitor.

Step	Action
1	Place the monitor in a plastic bag.
2	Locate a corrugated cardboard shipping carton with at least 200 psi (pounds per square inch) bursting strength.
3	Fill the bottom of the carton with at least 2 inches of packing materials.
4	Place the bagged unit on the layer of packing material and fill the box completely with packing material.
5	Seal the carton with packing tape.
6	Label the carton with the shipping address, return address, and RGA number, if applicable.

# RS-232 Interface

This chapter explains how to properly use and connect the RS-232 interface and cables.

---

## General RS-232 Safety Information

---

### **Warning**

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If you connect the monitor to any instrument, verify proper operation before clinical use. Refer to the device's manual for full instructions.

Accessory equipment connected to the monitor's data interface must be certified according to IEC Standard 950 for data-processing equipment or IEC Standard 60601-1 for electromedical equipment. All combinations of equipment must be in compliance with IEC Standard 60601-1 system requirements.

Anyone who connects additional equipment to the signal import port or signal output port configures a medical system and is therefore responsible to ensure that the system complies with the requirements of system standard IEC Standard 60601-1-1. If in doubt, consult the Philips Response Center or your local Philips representative.

---

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### **Caution**

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Connection to a battery operated PC should only be allowed by the end user.

Connection to a line powered device with an ITE Class II power supply is acceptable provided it passes all 60601-1-1 tests without a problem.

If there is a line powered device with a Class I power supply, such as a line powered PC or a laser printer, in the system, there must be either optical isolation of the data cable or the Class I devices must have isolated transformers.

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### **Note**

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The monitor and its accessories must be tested by qualified service personnel at regular intervals to verify proper operation, according to the procedures of the user's institution. Additional important safety information is located in the **C3 Instructions for Use** guide.

---

## About the RS-232 Interface

The RS-232 interface allows you to :

- send a nurse call signal
- export trend data to an external PC

---

### **Warning**

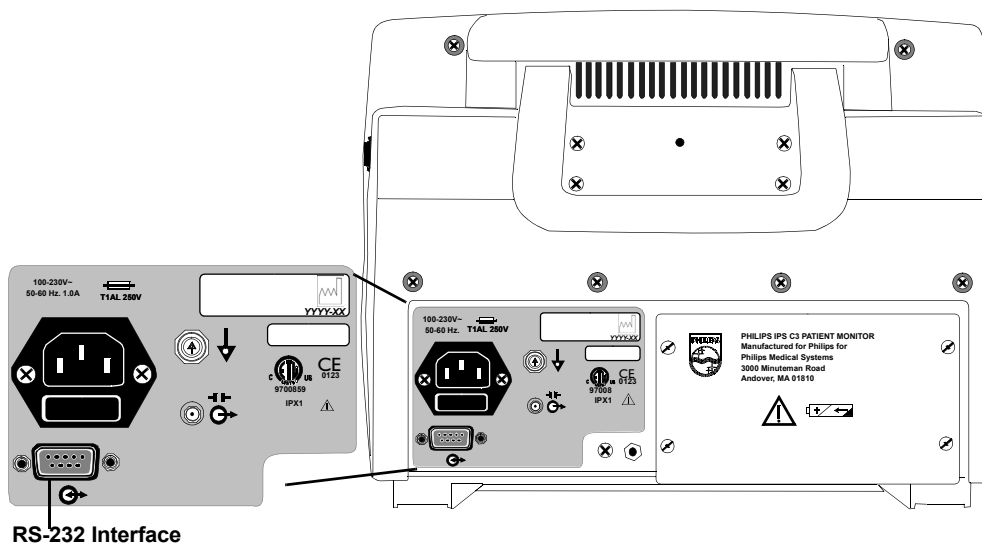
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**Anyone who connects additional equipment to the signal input port or signal output port configures a medical system and is therefore responsible to ensure that the system complies with the requirements of system standard IEC Standard 60601-1-1. If in doubt, consult Philips Medical Systems Response Center or your local Philips representative.**

---

### Cable Connections

A 9-pin connector mounted on the rear panel provides the access port for the serial (RS-232) interface to a suitably configured personal computer. Or, alternatively, qualified service personnel can use the connector to send a Nurse Call signal. The figure below shows you where the RS-232 interface is located on the monitor.



Pin connections for the 9-pin connector are as follows:

**Table 10-1. RS-232 Serial Interface Connections**

Pin #	Signal	Direction
1	not used	
2	Rx data	input
3	Tx data	output
4	DTR	output
5	Signal Ground	input/output
6	DSR	input
7	RTS	output
8	CTS	input
9	Alarm Out	output

## Nurse-Call

Pin 9 of the RS-232 serial interface connector provides an Alarm Out signal. Any time there is any alarm condition active in the monitor, and if the Nurse Call Signal option in the **Setup Menu** is On, pin 9 goes to plus RS-232 level voltage ( $> +5$  VDC). The alarm delay shall be  $< 0.5$  seconds.

If in the **Setup Menu**, the Nurse Call Signal option is Off, pin 9 is always at the minus RS-232 level voltage. In order to make use of the Alarm Out signal, pin 9 should be connected to a high-impedance circuit ( $>1000$ ) and protected against transient voltages.

# Training

This chapter provides a complete, flexible training program that addresses the needs of technical personnel who service the monitor at all levels of involvement.

---

## Introduction

The training itself is self-paced. This chapter guides you through the entire service training program. All of the information you require is in this chapter, or referred to in this chapter.

---

## Levels of Involvement

### **Preventative Maintenance Only**

If you are performing only preventative maintenance on the monitor, you must review the following sections of this chapter:

- Overview
- Preventative Maintenance

### **Phone Support or Service**

If you are providing phone support or servicing of the monitor, you must review the following sections of this document:

- Overview
- Support Strategies
- Theory of Operation and System Architecture
- Troubleshooting
- Monitor Applications and Algorithms
- Disassembly
- Preventative Maintenance



## Training Materials

### Essential Materials

The essential materials to complete this training are the following:

- The **C3 Service Guide** (989803129451)

For Philips Service Personnel, a Training Completion Form must be signed and returned to your supervisor referencing the course number "MWPMMD-C3SUPP".

### Optional Materials

Optional materials that can assist you in this training are the following:

- a C3 monitor
- **C3 Instructions for Use** guide
- Tools needed for performance verification of the monitor. Refer to the section titled, *"Equipment"* on page 4-8 for a listing of these tools.

## Overview

This section provides a high level overview of the monitors and their options.

Order Number	Description	Display	Measurements					Printout
		Color	ECG	NBP	Temp	SpO <sub>2</sub>	CO <sub>2</sub>	Recorder
862474	Standard Color	•	•	•	•	•		(optional)
862478	Sedation Color	•	•	•	•	•	•	(optional)

### Note

The monitor is designed for non-invasive use only.

Common use for this monitor includes:

- Physicians' offices
- Transport within a care facility
- Low-acuity monitoring in any clinical environment

---

## Support Strategies

This section provides a summary of how the monitor was designed to be supported and how Philips provides that support.

There are two main methods of repairing the monitor:

- Unit exchange
- Bench repair

### Unit Exchange

The primary repair method used by Philips service personnel is unit exchange. The current design of the monitor requires testing if the case is opened.

### Bench Repair

The secondary repair method is bench repair. Special tools are required and are listed in *"Equipment" on page 4-8*. If the case is opened, specific tests must be performed. These tests are listed in detail along with the Test Map in *Chapter 4*.

At the Philips Parts Center, we will stock the board level assemblies and mechanical parts based on existing failure data and customer demand. These parts are listed in *Chapter 8*. The availability of additional spare parts will be notified by service notes.

The troubleshooting guide in *Chapter 6* is sufficient for assembly level bench repairs. Before a repair is performed, consider whether a repair or a replacement is most suitable.

---

## Theory of Operation and System Architecture

This section contains a high level overview of the theory of operation of the major functional modules of the monitor. Philips service providers perform Bench Repair at the assembly level. For this purpose, they should review this high level information.

Please be aware that Philips only stocks assembly level parts.

### System Overview

The monitor is a full function monitor for use on adult and pediatric patients.

The functions performed by the system include monitoring patient ECG, heart rate, respiration rate, blood pressure, blood oxygen saturation, carbon dioxide<sup>1</sup>, and temperature.

In addition to monitoring and displaying the status of these physiological parameters, the instrument performs various microprocessor-programmed analytical functions, such as:

- Creating both visual and audible alarm signals when set limits are violated.
- Creating and displaying warning messages when conditions are detected that would degrade or prevent valid measurements.
- Creating and displaying trend waveforms or tabular data.
- Providing a synchronizing pulse for defibrillator operation.
- Providing input to an optional recorder for printout of current or trend waveforms or tabular data.

The monitor is essentially a battery-powered instrument. An internal charging unit is designed to accept an external AC line voltage. The charger uses the external power source to maintain a "float" voltage source available from the batteries.

### Block Diagram

The functions are represented graphically in the following figure. Each section of the System Block Diagram is described briefly in the text that follows the illustration. This is followed by more detailed descriptions of the theory of operation of each block.

---

1. Carbon Dioxide (CO<sub>2</sub>) monitoring is available only with **C3 Sedation** models.

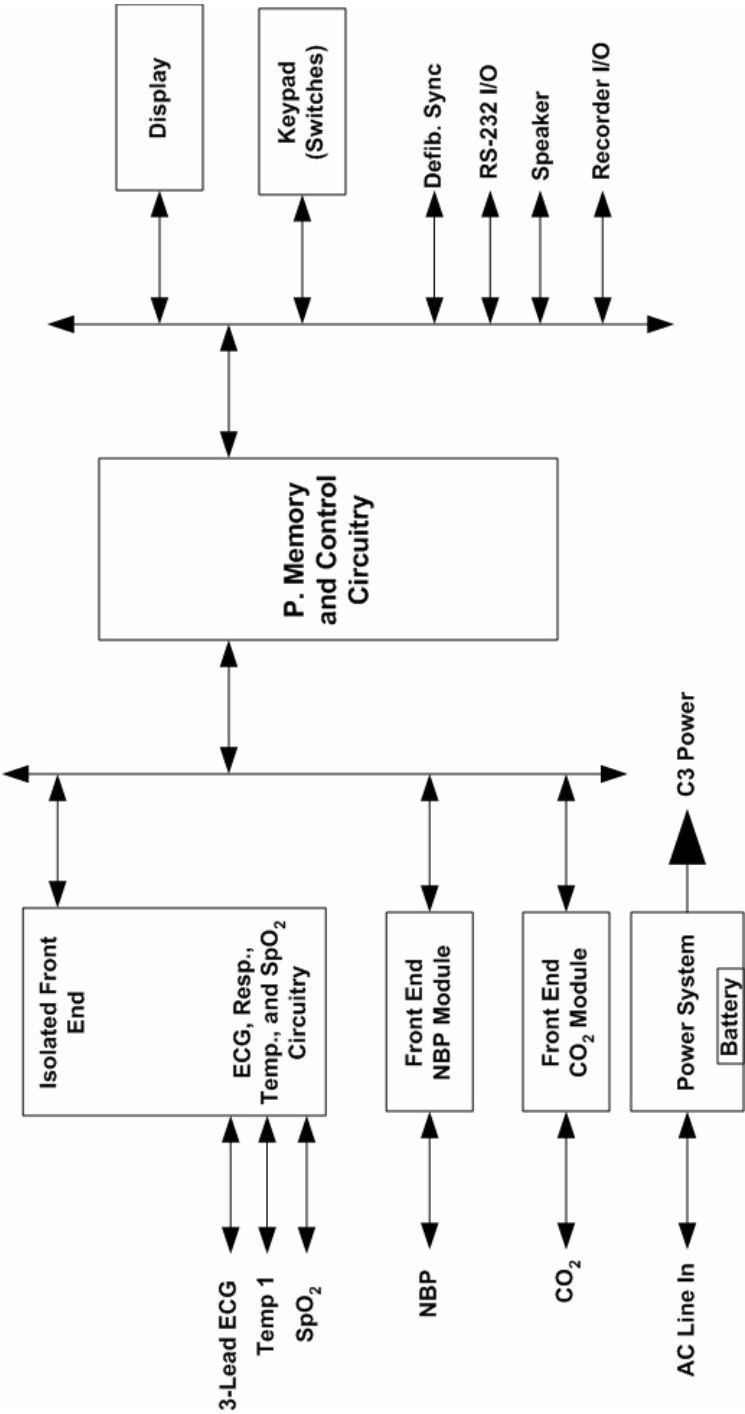


Figure 11-1 System Block Diagram

**Isolated Front End**

The Isolated Front End section includes all of the circuitry to convert ECG, SpO<sub>2</sub>, and Temperature measurements to digital format; and to connect this information to the processor. The Respiration detection is obtained from two of the three electrodes of the ECG connections.

**NBP Front End**

The NBP section contains the pumps, valves, pressure measurement circuitry, and control circuitry for the non-invasive blood pressure measurement. Pressure data is converted to digital format and conveyed to the processor section.

**Power System**

The power system section contains a power supply capable of operating the monitor and charging the battery from an AC source of 100 to 240 VAC at 50 to 60 Hz. This section also contains the circuitry. The battery provides the operating power for this power.

**Micro-processor, Memory and Control**

The Microprocessor, Memory and Control section contains the system CPU and all digital support circuitry. The latter includes the RAM, non-volatile memory, and real-time clock. This section also contains the display logic, keypad (switch) interface logic, RS-232 I/O control, defibrillator synchronization control, and printer logic.

**Display**

The display is a TFT (color), backlit fluorescent LCD unit. The active screen size is 8.3 x 6.2 in (210.8 x 157.5 mm); 10.4 in (264.2 mm) diagonally, and the resolution is 640 x 480 pixels.

**Keypad**

The keypad circuit contains five push-button membrane switches and two green LEDs. The LEDs are driven by the power supply system and indicate the power source.

Signals from LEDs are returned to the microcomputer for processing and control as required.

The **On/Standby** button, connected directly to the power supply, toggles the power between On and Standby modes. When in Standby, the display is blank, and no monitoring is performed. However, the batteries are charging if an AC source is connected to the rear panel.

The **Audio Alarm Control** button is connected directly to the processor and to the system power supply. Pressing this button turns off the battery fuse alarm in the system power supply. Response of the processor depends upon the action in pressing this button. If momentarily pressed (less than 2 seconds), alarms are paused temporarily for a preset interval determined by the menu selection. If pressed twice within 10 seconds, the alarm sounding for a specific parameter is silenced temporarily for a preset interval determined by the menu selection. Other alarms, not related to this parameter, can still sound during this period. If pressed and held for 2 seconds or more, the Audio Off condition is initiated.

The **NBP** button is connected to the processor. Response of the processor depends upon the state of NBP operation at the time and the action in pressing this button. If momentarily pressed, (less than 2 seconds), a single NBP measurement is obtained. If pressed for 2 seconds or more, the processor initiates a STAT monitoring sequence. Pressing the NBP switch at any time a pressure measurement is in effect causes the processor to terminate the measurement and to deflate the cuff.

The **Contrast** button operates in conjunction with the navigation wheel to determine the apparent contrast setting in the display. Changing the contrast is a change in the viewing angle. Outputs of the button and wheel are connected to the processor.

Momentarily pressing the button sets the contrast to mid-range, factory-default value.

Momentarily pressing of the button, followed within 3 seconds by a rotation of the wheel are processed to vary the contrast of the display. When there has been no wheel rotation for 3 seconds, the contrast control function is terminated by the processor. The contrast control function is also terminated if the wheel is pressed any time within this 3 second interval.

Operation of the **Volume** button accomplishes similar functions for the volume of the heart rate audible tone as the display contrast control button does for the display. Pressing this button, enables the wheel to vary the tone volume.

## Navigation Wheel

This is a rotating, push-switch wheel. The associated wheel circuitry generates a pulse when pressed and generates a digitally encoded pair of quadrature signals whose relative magnitudes and polarities represent the angular position of the wheel. These outputs are connected to the processor where they are interpreted as required for the functions involved. Successive angular positions determine the direction of wheel rotation.

In addition to the functions performed when in conjunction with the keypad as described above, the wheel operates in conjunction with the display to select menus and lists of parameter variables.

## RS-232 I/O

This is a rear panel 9-pin connector providing interfaces with other computer systems or equipment. The driver for this "port" is a Universal Asynchronous Receive-Transmit (UART) integrated circuit that interfaces this port with the microprocessor. The baud rate for this serial transmission function is programmable from 1200 baud to 38.4 kilobaud.

Pin number 9 of the RS-232 connector is reserved for a Nurse Call signal. The nurse call signal reacts when a low, medium, or high level alarm is activated.

## Defib Sync Pulse

The rear panel connector for the Defib Sync Pulse is keyed so that the connection of a cable can be detected by the processor. When a connection is detected, the processor software initiates the generation by hardware of a TTL-compatible pulse capable of driving 1 TTL load over a three-meter cable with less than 200 pF capacitance.

The defib pulse is triggered by the detection of the R-wave in the QRS sequence of the ECG wave-form complex. The pulse signal is active for  $100 \pm 10$  ms.

## Speaker

The speaker is capable of providing 73 dBA of volume at a distance of one meter during alarm conditions. The processor drives the speaker in different patterns as specified for the different alarm priorities and conditions. Refer to the **C3 Instructions for Use** guide for descriptions of alarm responses.

## Recorder

The optional recorder module is installed in the right panel of the monitor. Refer to the **C3 Instructions for Use** guide for printing procedures. It provides users with the capability to obtain hard-copy records of selected vital sign information.

Basic control of the recorder is implemented by two push-button controls on the recorder's front panel. The **Continuous** button is used to obtain continuous recordings of the real-time waveforms displayed in the top two graphic frames. Along with the waveforms, the recorder prints the values of the vital signs being displayed. The printing continues until the user presses either recorder button a second time.

The **Snapshot** button initiates a snapshot printout for 20 seconds of the same information recorded by the continuous control.

If scrolling is enabled in a display frame containing trend data when the **Continuous** button is operated, then the trend record for that vital sign is printed. If the **Snapshot** button is operated, then only the trend data on the display is printed.

The recorder may be programmed via the monitor menu display to print a snapshot recording when an alarm condition occurs.

Printing is accomplished on 50 mm wide thermal paper at recorder speeds programmable up to 55 mm/s.

## ECG Processing

The technique used in ECG senses the varying potential difference between two points at the skin surface which respond to the electro-chemical actions of the muscular activity of the heart.

Three electrodes are attached to the patient's right arm (RA), left arm (LA) and left leg (LL). The varying potentials at these locations are cable-connected to the ECG circuit inputs where they are conditioned, and the difference of potential between two selected leads is digitized before transmitting through opto-isolators to the processor. The processor-installed algorithms operate on the signals to develop drivers for the graphic display and to compute the heart rate in beats per minute (BPM).

In addition to the acquisition of the QRS waveform complex, the ECG input and subsequent signal processing computing circuitry perform a number of other functions:

- They detect a "lead-off" condition if one of the electrode connections is disrupted.
- They detect the presence of pacemaker signals within the QRS waveform complex of the ECG.
- They generate a synchronization pulse for external use with defibrillators. The Defib Sync Pulse output is available at a connector in the rear panel.

## Respiration Processing

The patient's respiration is detected by using two of the three leads of the ECG electrodes and cable. A low-level excitation signal is applied to these leads, and the variation of the thoracic impedance caused by the breathing is sensed and processed for display and measurement.

## **NBP Processing**

The NBP processing uses an oscillometric technique to provide needed measurements at selected intervals. This technique uses an inflatable sphygmomanometer cuff similar to those used by clinicians in routine measurements.

A motorized pump inflates the cuff to approximately 180 mmHg initially, at which point the pressure effectively stops the flow of blood. Then, under monitor control, the pressure in the cuff is gradually reduced, while a pressure transducer detects the air pressure and transmits the parameter signal to the NBP input circuitry.

As the pressure is reduced, blood flows in the previously occluded artery, and changes the measurements made by the transducer. The point at which oscillation increases sharply is defined as systolic pressure. As the cuff continues to deflate, oscillation amplitude increases to a maximum, and then decreases. The peak oscillation amplitude is defined as the mean arterial pressure. The point at which the system detects a rapid decrease in oscillation is defined as the diastolic pressure.

## **SpO<sub>2</sub> Processing**

Measurement of oxygen saturation in the blood uses a spectrophotometry technique. It is based on the facts that oxyhemoglobin and deoxyhemoglobin differ in their absorption of red and infrared light, and that the volume of arterial blood in tissue changes during the pulse.

Using these facts, a pulse oximeter passes red and infrared light into an arteriolar bed and measures changes in light absorption during the pulsatile cycle. The light sources are red and infrared light emitting diodes (LEDs), while the detection is accomplished by a photo diode.

To identify the oxygen saturation of arterial hemoglobin, the monitor uses the pulsatile nature of arterial flow. During systole, a new pulse of arterial blood enters the vascular bed, and both blood volume and light absorption increase. During diastole, blood volume and light absorption reach their lowest point. The measurement is based upon the difference between maximum and minimum absorption, focusing on the pulsatile arterial blood.

In addition to the oximetry function, the input signals may be used to calculate heart rate.

## **CO<sub>2</sub> Processing**

The Microstream CO<sub>2</sub> board consists of an 80C552 Controller, the memory system (Flash ROM, RAM, PLA, etc.), the Flow system (FilterLine recognition system, Inlet, solenoid valve), Measurement Cell (Exciter, IR Source, Detectors and Temp Sensor) and an analog section with ADC.

The gas inlet allows the connection of Microstream FilterLines. The FilterLines are detected by the Optical Code Recognition.

## **Temperature Processing**

Measurement of patient temperature is accomplished by processing the signal from a probe containing a resistor whose impedance is temperature dependent. The class of such components is called thermistor.

The C3 is designed to accept the signals from electrically isolated Series 400 probes manufactured by Yellow Springs Incorporated. Interchangeable probes in this series may be used for esophageal, rectal, skin or surface, or airway temperature measurement. Probes are furnished with a standard 10-foot lead. Extension leads are available.

The signal from the probe is conditioned by the monitor's input circuitry, processed, and used to drive the numeric display.



## Troubleshooting

Service personnel concerned with troubleshooting should review the following topics in this manual:

- Error Codes (see ***“Error Codes” on 6-3***)
- Boot Sequence (see ***“Performance Assurance Test” on 4-11***)
- Performance Verification (see ***“Performance Procedures” on 4-22***)

This is intended to be a practical, hands-on part of the training program. If possible, therefore, use a monitor to help you learn about troubleshooting the monitor.

When faced with a call regarding the monitor, there are some simple steps that are recommended to solve the failures described below. These failures account for the majority of known failure modes.

Symptom	Cause of Failure	Remedy
Monitor screen appears dim	Brightness not properly adjusted.  Display backlight tube worn.	Adjust brightness using <b>Contrast</b> button.  Replace backlight tube according to instructions in <b><i>“Replacing the Backlight Tube” on page 9.</i></b>
Monitor screen is blank	Display backlight tube worn or loose connection.  Main PCB module malfunction.	1. Check the backlight tube connector 2. Replace the backlight tube  Replace the Main PCB module according to instructions in <b><i>“Removing the Main PCB Module” on 7-12.</i></b>
Monitor fails to power-up when the <b>On/Standby</b> button is pressed.	Battery is dead or monitor is not plugged in.  Keypad malfunction or keypad connector is loose.	Make sure the monitor is powered on by either battery or AC power. Check that the battery is adequately charged and AC power fuses are securely connected.  1. Check the keypad connector. 2. Replace the keypad according to the instructions in <b><i>“Removing the Keypad on the Front Panel” on 7-6.</i></b>
No response when pressing the buttons on the front panel	Keypad malfunction or keypad connector is loose.	1. If only one button does not work, verify that the monitor is On. 2. Check the keypad connector 3. Replace the keypad according to the instructions in <b><i>“Removing the Keypad on the Front Panel” on 7-6.</i></b>

Audible alarm does not sound	Speaker malfunction or speaker has a loose connector.	1. Check speaker connector. 2. Replace speaker according to the instructions in <b><i>“Replacing the Speaker” on 7-9.</i></b>
	Main PCB module malfunction.	Replace the Main PCB module according to the instructions in <b><i>“Removing the Main PCB Module” on 7-12.</i></b>
No sound from monitor	Tone is switched off or low.	1. Turn the volume up by pressing the <b>Volume</b> button. 2. Power-cycle monitor. Tone should sound when monitor boots up. 3. Check cable connections to the speaker.
No tone alarms	Audible alarms are not switched on.	Make sure audible alarms are switched on.
Speaker will not work	Cable disconnected.	Reconnect cable.
	Defective speaker.	Replace speaker.
The wheel is rotated, no highlight appears on the display screen, and/or the monitor does not respond to wheel presses.	Main PCB module malfunction.	Replace the Main PCB module according to the instructions in <b><i>“Removing the Main PCB Module” on 7-12.</i></b>

Whenever the monitor has been opened, there are specific steps regarding reassembly, described in the disassembly instructions in *Chapter 7*, that must be followed. If these instructions are not followed, various errors may result.

For monitors that are defective on arrival, first verify that the problems are not related or cannot be remedied by following the steps in the above troubleshooting table. If these are not successful, and a replacement monitor is necessary, contact a Philips Sales Representative to arrange a replacement.

## Disassembly

Disassembly procedures are described in the disassembly guide in *Chapter 7*. Read the whole chapter.

Whenever the monitor has been opened, there are specific steps regarding reassembly, described in the disassembly instructions in *Chapter 7*, that must be followed. If these instructions are not followed, errors may result.

If the monitor fails the required performance tests described in Chapter4, then please review the reassembly.

---

## Monitor Applications and Algorithms

Information about...	Found in...
Supplies	<a href="http://shop.medical.philips.com">http://shop.medical.philips.com</a> or <i>Chapter 16, "Accessories" in the <b>Instructions for Use</b> guide, Technical Data Sheet</i>
Basic monitor specifications	<i>Chapter 12, "Specifications", Technical Data Sheet</i>
Regulatory Compliance	<i>Chapter 12, "Specifications", Technical Data Sheet</i>
Other data about algorithms	<i>Chapter 12, "Specifications", Technical Data Sheet</i>



# Specifications

This chapter includes all hardware, regulatory, and measuring specifications for the monitor.

## Hardware Specifications

Parameter	Specification
<b>Size (excluding handle)</b>	
Width	13.50 in (34.3 cm)
Height	10.25 in (26.0 cm)
Depth	7.50 in (19.0 cm)
Weight (excluding accessories, options, cables)	14.0 lb (6.3 kg)
<b>Display (cold cathode fluorescent backlit)</b>	
Screen Type	TFT (color)
Active Screen Size	8.3 x 6.2 in (210.8 x 157.5 mm): 10.4 in (264.2 mm) diagonally
Resolution	640 x 480 pixels
<b>Recorder</b>	
Type	Thermal
Weight	0.9 lb (.41 kg)
Paper Width	50 mm
Speeds	12.5, 25, and 50 mm/s

## Safety Standards

Parameter	Specification
United States Federal Law restricts this device to sale by or on the order of a physician.	
CE Marking: Medical Device Directive, 93/42/EEC	
IEC 60601-1, UL 2601, Can/CSA C22.2 601.1-M-90	
Protection Class	Class I, internally and externally powered equipment, per IEC 60601-1, clause 2.2.4
Degree of Protection	Type CF, IPXI: per IEC 60601-1
Mode of Operation	Continuous

## Electrical

Parameter	Specification
<b>Power Sources</b>	
Internal Battery	12 volt, 4.5 Ah, sealed, lead-acid
Battery Operating Time	3 hours, fully charged battery at 25°C (without CO <sub>2</sub> ) under normal (one NBP measurement every 15 minutes, all other modes active) conditions, 45 minutes if printing continuously, 1 hour, fully charged battery at 25°C (with CO <sub>2</sub> ) under normal conditions, 30 minutes if printing continuously.
AC Mains	100 to 240 VAC, 50-60Hz, 1A max

## Environmental

Parameter	Specification
Mechanical Shock	IEC 60068-2-27; 100g, 6 msec, 3 axes, 18 total shocks, non-operating
Mechanical Vibration	IEC 60068-2-6; Sinusoidal; 10-58 Hz, 0.15 in displacement; 58-150 Hz, 2g acceleration; 4 min/sweep; 20 sweeps/axis, non-operating
Water Resistance	IEC 60529 Classification IPX1 (Protected against vertically dripping water)
<b>Thermal</b>	
Operating	0 to 50°C (32 to 122°F)
Storage	-20 to 60°C (-4 to 140°F)
<b>Humidity</b>	
Operating	5 to 95% RH, non-condensing
Storage	5 to 95% RH, non-condensing

## Measuring and Displaying Parameters

### ECG

Parameter	Specification
Heart Rate Range	20-250 b/min
Heart Rate Accuracy	$\pm 5$ b/min
Bandwidth: Normal Monitoring	0.5 Hz - 40 Hz
Bandwidth: Extended Low Frequency Range (use selectable)	0.05 Hz - 40 Hz
Leads	3 lead, user selectable
Display Sweep Speeds	12.5, 25, and 50 mm/sec
Pacemaker Detection	Indicator on waveform display, user selectable
ECG size (sensitivity)	0.5, 1, 2, 4 mV/cm
Lead-off Detection	detected and displayed
Input Impedance	$>5 \text{ M}\Omega$
CMRR (Common Mode Rejection Ratio)	$>90 \text{ dB}$ at 50 or 60 Hz
Input Dynamic Range	$\pm 5 \text{ mV AC}$ , $\pm 300 \text{ mV DC}$
Defibrillator Discharge	$<5 \text{ sec}$ per IEC 60601-2-27
Recovery	$<8 \text{ sec}$ per AAMI EC13-1992



## ECG Standards

Standards		
Meets the performance standards of ANSI/AAMI EC13-1992. Instead of a 1 mV standardizing voltage (section 3.2.2.9), a fixed, 1 cm reference bar is always present in the ECG display, along with the ECG size setting expressed in mV/cm. The following information references particular sections of ANSI/AAMI EC13-1992.		
Respiration, leads-off sensing waveform. 3.1.2.1 (b)	A 85 kHz square wave is used to inject 50 $\mu$ A p-p differentially between RA and LL.	
Tall T-wave rejection. 3.1.2.1 (c)	T-wave of 0.8 mV amplitude will not affect heart rate determination.	
Heart rate averaging. 3.1.2.1 (d)	Averages six of the most recent eight detected R-R intervals excluding the longest and shortest of the eight intervals.	
Response to irregular rhythms 3.1.2.1 (e)	a) Ventricular bigeminy - 80 b/min rhythm. b) Slow alternating ventricular bigeminy - 30 b/min c) Rapid alternating ventricular bigeminy - 80 to 103 b/min d) Bi-directional systoles - 90 to 105 b/min	
Heart rate meter response time. 3.1.2.1 (f)	a) Change from 80 to 120 b/min: 4 to 5 sec b) Change from 80 to 40 b/min: 6 to 8 sec	
Time to alarm for tachycardia. 3.1.2.1 (g)	Waveform 4(a) Amplitude <ul style="list-style-type: none"> <li>• 0.5 mV</li> <li>• 1.0 mV</li> <li>• 2.0 mV</li> </ul>	Average Time to Alarm <ul style="list-style-type: none"> <li>• 8.6 sec</li> <li>• 7.0 sec</li> <li>• 3.0 sec</li> </ul>
	Waveform 4(b) Amplitude <ul style="list-style-type: none"> <li>• 1.0 mV</li> <li>• 2.0 mV</li> <li>• 4.0 mV</li> </ul>	Average Time to Alarm <ul style="list-style-type: none"> <li>• 8.0 sec</li> <li>• 2.4 sec</li> <li>• 2.4 sec</li> </ul>

Standards		
Pacemaker pulse rejection. 3.1.4.1, 3.1.4.2	With the exceptions noted below, the monitor will reject all single and double pacemaker pulses either 150 or 250 msec apart of amplitudes $\pm 2$ to $\pm 700$ mV from 0.1 to 2.0 msec, with and without under/overshoot. Following are pacer pulse conditions that the monitor will reject, but which are less than the maximum range listed in the standard:	
	Pacer pulse width = 2 msec, Double pulse, either 150 or 250 msec apart without over/undershoot, no QRS	Pacer amplitude $\leq \pm 400$ mV
	Pacer pulse width = 2 msec, Double pulse either 150 or 250 msec apart, without over/undershoot, ineffective pacer	Pacer amplitude $\leq \pm 500$ mV
	Pacer pulse width = 2 msec, Single or Double pulse either 150 or 250 msec apart, with 2 mV over/undershoot, no QRS.	Pacer amplitude $\leq \pm 125$ mV
	Pacer pulse width = 2 msec, 250 msec spaced double pulse, with 2 mV over/undershoot, effective pacing.	Pacer amplitude $\leq \pm 300$ mV
	Pacer pulse width = 2 msec, 150 msec spaced double pulse, with 2 mV over/undershoot, ineffective pace.	Pacer amplitude $\leq \pm 220$ mV
	Pacer pulse width = 2 msec, 250 msec spaced double pulse, with 2 mV over/undershoot, ineffective pace.	Pacer amplitude $\leq \pm 120$ mV

## Respiration

Parameter	Specification
Technique	Trans-thoracic impedance
Range	3 to 150 breaths/min
Accuracy	$\pm 3$ breaths/min
Leads	RA to LA
Display Sweep Speeds	6.25, 12.5, 25 mm/s
Lead Off Condition	detected and displayed

**NBP (Non-Invasive Blood Pressure)**

Parameter	Specification
Standards	Meets performance standards of ANSI/AAMI SP10-1992
Technique	Oscillometric
Cuff Pressure Display	10 to 300 mmHg
Pulse Rate Range	40 to 200 b/min
Blood Pressure Accuracy	Mean error and standard deviation per ANSI/AAMI SP10-1992 <sup>a</sup>
Pulse Rate Accuracy	Greater of $\pm 2$ BMP or $\pm 2\%$
Initial Cuff Inflation	180 mmHg
Subsequence Cuff Inflation	Prev SYS $\pm 30$ mmHg
<b>Blood Pressure Measurement Range</b>	
Systolic	60 to 250 mmHg
Diastolic	40 to 220 mmHg
Mean Arterial Pressure	45 to 235 mmHg
<b>Measurement Modes</b>	
Auto	Automatic measurements at intervals of 1, 3, 5, 10, 30, 60 and 90 minutes
Manual	Single measurement initiated by Start/Stop button
STAT	Series of consecutive measurements for 5 minutes

a. Systolic and Diastolic blood pressure measurements determined with this device are equivalent to those obtained by a trained observer using the cuff/stethoscope auscultation method, and mean pressure measurements determined with this device are equivalent to those obtained by an intra-arterial blood pressure measurement device, within the limits prescribed by the American National Standard, Electronic or automated sphygmomanometers.

**Temperature**

Parameter	Specification
Technique	Probe
Range	15 to 45°C (59 - 113°F)
Accuracy	$\pm 0.1^\circ\text{C}$

**SpO<sub>2</sub>**

Parameter	Specification
<b>Range</b>	
% Saturation	0 to 100%
Pulse Rate	30 to 300 b/min
<b>Accuracy</b>	
SpO <sub>2</sub>	0 - 69% ± not specified; M1191A, M1192A ± 2.5% (70 to 100%) M1194A ± 4.0% (70 to 100%)  Accuracy <sup>a</sup> with Philips disposable sensors (M1902B, M1903B, M1904B) and with Nellcor disposable sensors (OxiCliq A, P, N, I) 3% (70 to 100%).
Pulse Rate	2% or 1 b/min (whichever is greater)
Display Update Period	1 sec
Calibration	functional

a. The specified accuracy is the root-mean-square (RMS) difference between the measured values and the reference values.

**CO<sub>2</sub>**

Complies with EN 864/ISO 9918

Parameter	Specification
Range	0 to 98 mmHg (0 to 13 kPa), or 13% CO <sub>2</sub> whichever is lower.
Flow Rate	50 ±7.5 ml/min
Warm-up Time	180 seconds max.; typically 30 seconds
Gas Sampling Delay Time	2.7 seconds
<b>Resolution</b>	
Numeric	1.0 mmHg (0.1 kPa)
Wave	0.1 mmHg (0.01 kPa)
Rise Time	190 ms for adult mode (measured with sample line for humidified ventilation and airway adapter for adult)
Calibration Interval	4,000 operating hours
Auto Zero Interval	< 2% duty cycle. Increases if the temperature change by 8°C from the previous Auto-Zero interval, or the pressure changes by 45 mmHg.
Leak Tightness	< 40 mbar/min with 30% vacuum
<b>Accuracy<sup>a</sup></b>	
0 - 20 minutes	0 to 38 mmHg ±4 mmHg; 38 to 99 mmHg ±12% of indicated value
> 20 minutes	0 to 38 mmHg ±2 mmHg 38 to 99 mmHg ±5% of indicated value + 0.08% for every 1.0 mmHg above 40 mmHg.

a. Accuracy applies for respiration rate up to 80 b/min. For respiration rate above 80 b/min, the accuracy complies with EN 864/ISO 9918 (4 mmHg or ±12% of indicated value, whichever is greater) for End-tidal CO<sub>2</sub> values exceeding 19 mmHg. The above accuracy is maintained to within 4% for the following gas mixtures: CO<sub>2</sub>: 0 - 13%; N<sub>2</sub>: 0 - 97.5%; O<sub>2</sub>: 0 - 100%; N<sub>2</sub>O: 0 - 80%; H<sub>2</sub>O: Dry to saturated.

## Trends

Parameter	Specification
Type	Graphical and tabular
Memory Storage	12 hours, nonvolatile
Data interval	20 seconds (stored data points is the average over 20-second interval)
<b>Graphical Trend</b>	
Format	One graph per vital sign
Display range	2 hours, scrollable
<b>Vertical scaling</b>	
Heart Rate	50-100, 0-250, 25-125 b/min
NBP	50-100, 0-150, 0-300 mmHg
SpO <sub>2</sub>	0-100, 60-100, 80-100%
CO <sub>2</sub>	0-100, 0-60, 20-50 mmHg
Respiration Rate	0-20, 0-50, 0-150 b/min
Temperature °C	15-45, 33-41, 35-39°C
Temperature °F	55-115, 91-107, 96-102°F
Tabular format	One table for all variables. Six fields per row (time and five vital signs)
Display interval	Per NBP measurement, or 15 minutes for no NBP, or 20 seconds during alarm condition